# Understanding Dosimetry in Y-90

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# Disclosures

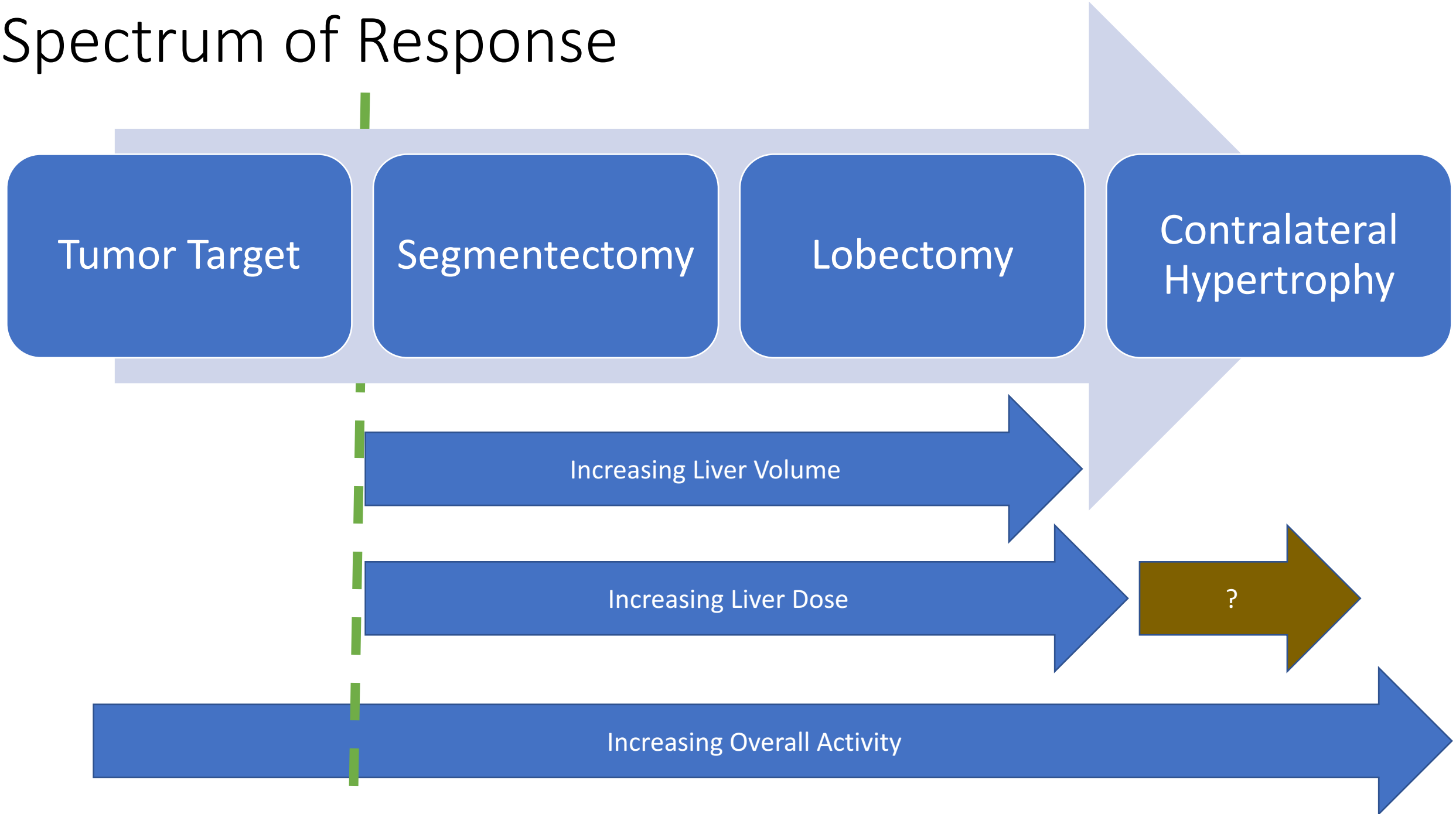
**David Liu:** Consultant – Sirtex Medical, Ethicon Endocare/Neuwave Medical; Grant/Research Support – BTG Medical; Speakers' Bureau – Servier Pharmaceuticals; Other Financial or Material Support – Merit Medical: Independent Director

David Liu has disclosed that the off-label use of SIR-Spheres® Y-90 microspheres; TheraSphere® Y-90 microspheres will be discussed.

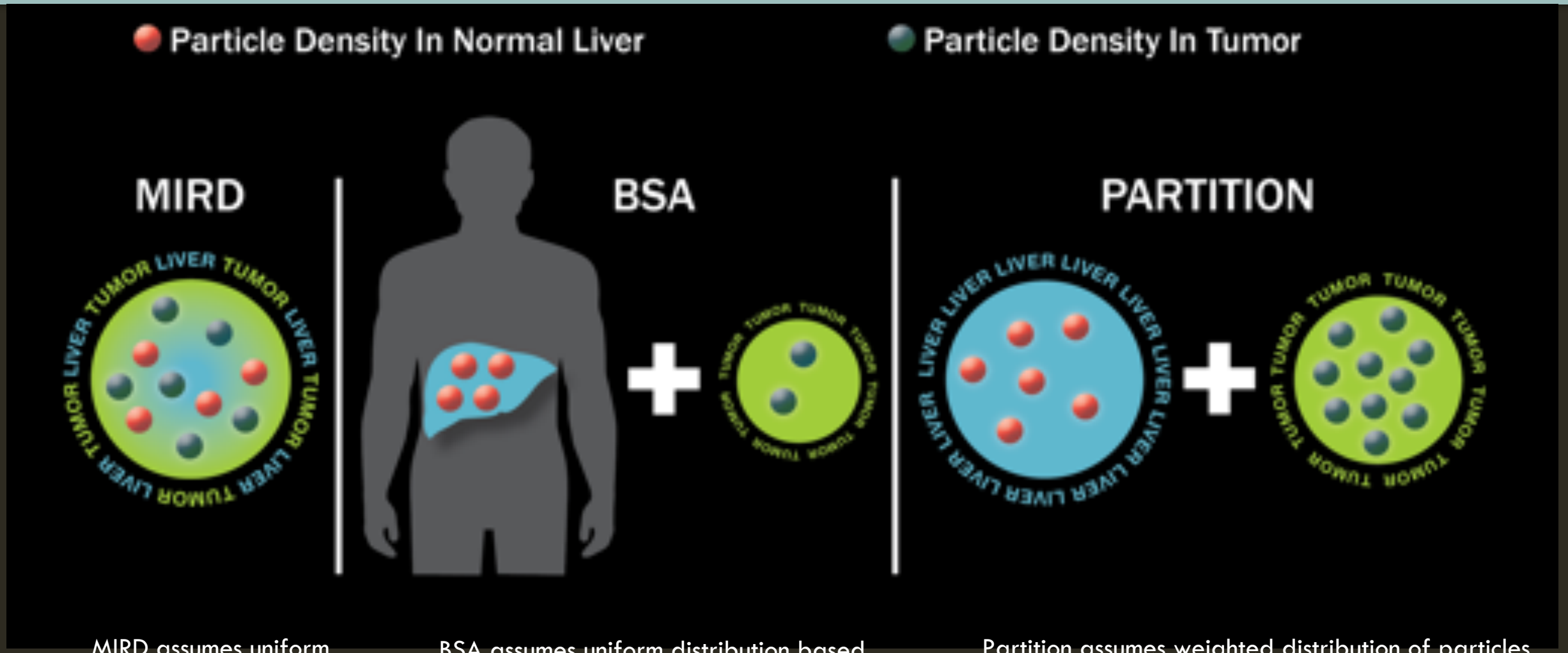
*Brand names are included in this presentation for participant clarification purposes only.*

*No product promotion should be inferred.*

# Spectrum of Response



# ACTIVITY CALCULATIONS AND PRESUMED RADIATION/PARTICLE DISTRIBUTION/DOSE




MIRD assumes uniform distribution

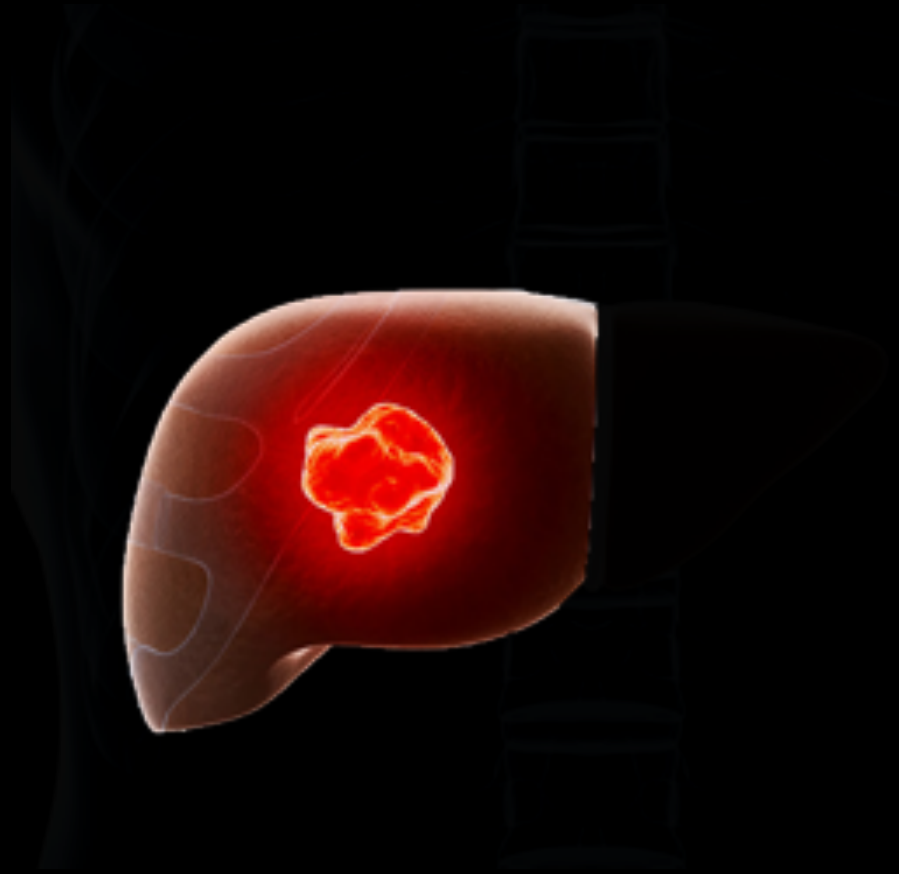
BSA assumes uniform distribution based on theoretical liver + tumor

Partition assumes weighted distribution of particles based on volume and T:N


YOU SAY YOU FINALLY GET BS'A'?
BUT YOU STILL FULL OF BS!


YOU COMMIT MIRD-IR
WHY NO PARTITION?

# CONVENTIONAL APPROACH



Target the tumor dose

Confirm safe margin for lung

Confirm safe margin for liver

## Conventional Approach

- Targeting the tumor
- Liver exposure is collateral damage

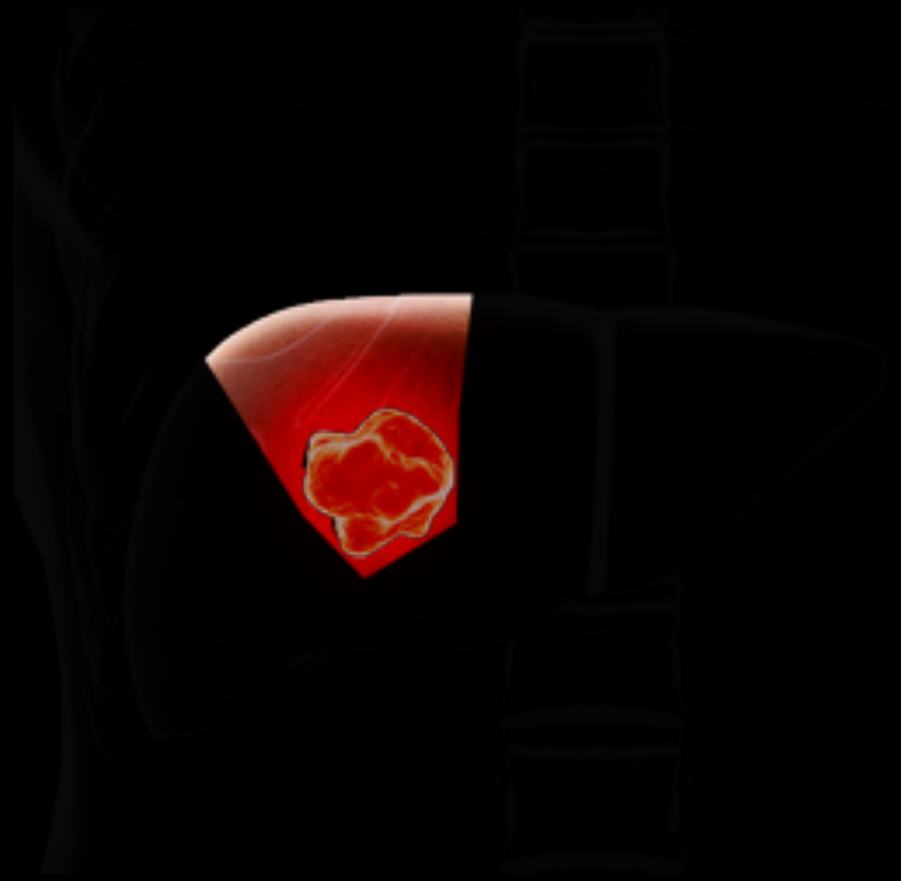
## Segmentectomy Approach

- Targeting liver parenchyma
- Tumor sumps activity

## Lobectomy Approach

- Targeting the liver parenchyma
- Tumor sumps activity

# RADIATION SEGMENTECTOMY APPROACH



Target the dose to liver (<70 Gy)

Confirm safe margin for lung

Calculate sump to tumor

## Conventional Approach

- Targeting the tumor
- Liver exposure is collateral damage

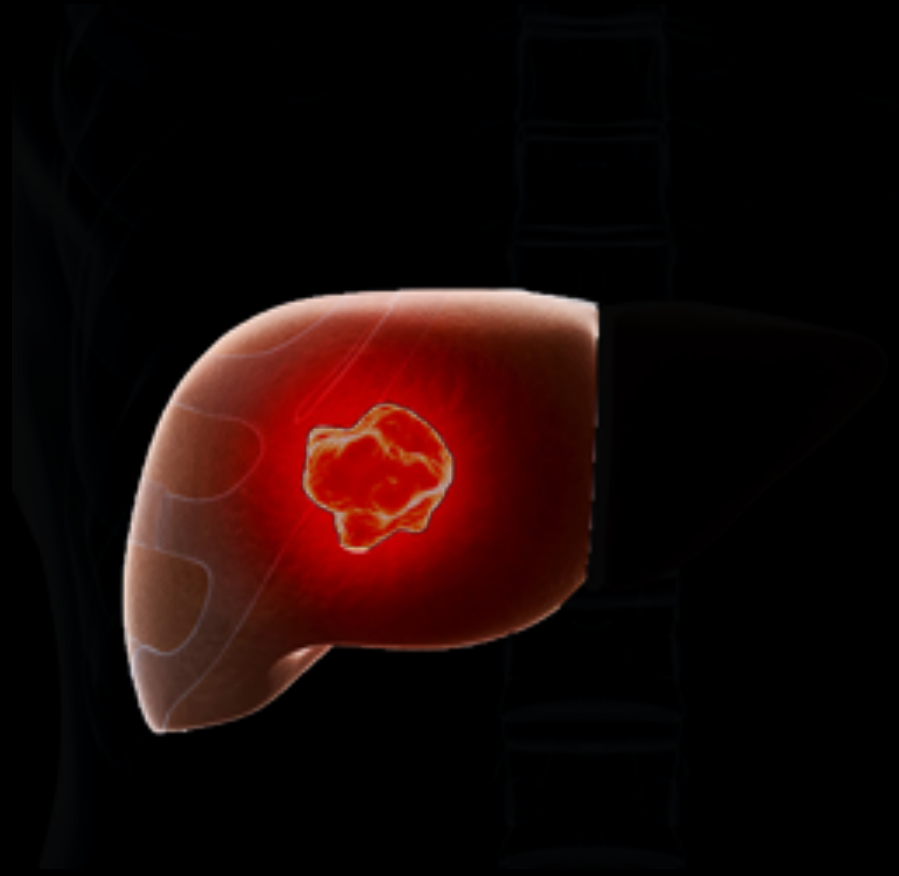
## Segmentectomy Approach

- Targeting liver parenchyma
- Tumor sumps activity

## Lobectomy Approach

- Targeting the liver parenchyma
- Tumor sumps activity

# RADIATION LOBECTOMY APPROACH



Target the dose to liver (<70 Gy)

Confirm safe margin for lung

Calculate sump to tumor

## Conventional Approach

- Targeting the tumor
- Liver exposure is collateral damage

## Segmentectomy Approach

- Targeting liver parenchyma
- Tumor sumps activity

## Lobectomy Approach

- Targeting the liver parenchyma
- Tumor sumps activity

# PARTITION AS A LAUNCH POINT

| Specific Activity | Conventional | Segmentectomy Lobectomy |
|---|---|---|
| Glass ‘Like’ | Tumor >190 Gy | MIRD 190 Gy |
| Resin ‘Like’ | Tumor >100 Gy | Liver >70 Gy |

# ONE SPHERE TO RULE THEM ALL

EDITORIAL COMMENTARY

# The dosimetric importance of the number of $^{90}Y$ microspheres in liver transarterial radioembolization (TARE)

Carlo Spreafico · Marco Maccauro · Vincenzo Mazzaferro · Carlo Chiesa

"…reported calculations [should] emphasize the importance of the number of microspheres per GBq [and] this should be considered a crucial variable in clinical trials…"

Spreafico C, et al. *Eur J Nucl Med Mol Imag*. 2014;41(4):634-638.

# 3 GBQ OF ACTIVITY FLEX & EX

SIR-Spheres®
16.5-40 million
Day -3 to day 0 from 'calibration'

16.5-27 million overlap

TheraSphere®
1.2-27 million
Day 0 to day 12 from 'calibration'

# NOW THAT I HAVE SO MANY WAYS TO GIVE THE SAME ACTIVITY, HOW DO I CHOOSE?

Hypovascular

Radiation segmentectomy

Radiation lobectomy

Larger tumor distribution

Poor vascularity in target

Liver parenchymal preservation in lobar infusion

# PRE-CALIBRATION

Calculation from Calibration (18:00 Eastern Time) to Assay Time

## DAY THREE PRE-CALIBRATION

| | Hours Before Cal | Decay Factor | Activity (GBq) | Activity (mCi) |
|---|---|---|---|---|
| 8:00 AM | 82 | 2.427 | 7.281 | 196.79 |
| | 81.5 | 2.414 | 7.242 | 195.73 |
| 9:00 AM | 81 | 2.401 | 7.203 | 194.68 |
| | 80.5 | 2.388 | 7.164 | 193.63 |
| 10:00 AM | 80 | 2.375 | 7.126 | 192.58 |
| | 79.5 | 2.362 | 7.087 | 191.55 |
| 11:00 AM | 79 | 2.350 | 7.049 | 190.51 |
| | 78.5 | 2.337 | 7.011 | 189.48 |
| NOON | 78 | 2.324 | 6.973 | 188.46 |
| | 77.5 | 2.312 | 6.936 | 187.45 |
| 1:00 PM | 77 | 2.299 | 6.898 | 186.44 |
| | 76.5 | 2.287 | 6.861 | 185.43 |
| 2:00 PM | 76 | 2.275 | 6.824 | 184.43 |
| | 75.5 | 2.262 | 6.787 | 183.44 |
| 3:00 PM | 75 | 2.250 | 6.751 | 182.45 |
| | 74.5 | 2.238 | 6.714 | 181.46 |
| 4:00 PM | 74 | 2.226 | 6.678 | 180.49 |
| | 73.5 | 2.214 | 6.642 | 179.51 |
| 5:00 PM | 73 | 2.202 | 6.606 | 178.54 |
| | 72.5 | 2.190 | 6.571 | 177.58 |

To calculate the percentage of spheres drawn from the vial, please divide the GBq drawn by the activity at the time of draw, as noted in this Radioactive Decay Dosing Chart.

## DAY TWO PRE-CALIBRATION

| | Hours Before Cal | Decay Factor | Activity (GBq) | Activity (mCi) |
|---|---|---|---|---|
| 6:00 PM | 72 | 2.179 | 6.535 | 176.62 |
| | 71.5 | 2.167 | 6.500 | 175.67 |
| 7:00 PM | 71 | 2.155 | 6.465 | 174.72 |
| | 70.5 | 2.143 | 6.430 | 173.78 |
| 8:00 PM | 70 | 2.132 | 6.396 | 172.84 |
| | 69.5 | 2.120 | 6.361 | 171.91 |
| 9:00 PM | 69 | 2.109 | 6.326 | 170.99 |
| | 68.5 | 2.097 | 6.292 | 170.06 |
| 10:00 PM | 68 | 2.086 | 6.258 | 169.15 |
| | 67.5 | 2.075 | 6.225 | 168.23 |
| 11:00 PM | 67 | 2.064 | 6.191 | 167.33 |
| | 66.5 | 2.053 | 6.158 | 166.43 |
| MIDNIGHT | 66 | 2.042 | 6.125 | 165.53 |
| | 65.5 | 2.031 | 6.092 | 164.64 |
| 1:00 AM | 65 | 2.020 | 6.059 | 163.75 |
| | 64.5 | 2.009 | 6.026 | 162.86 |
| 2:00 AM | 64 | 1.998 | 5.994 | 161.99 |
| | 63.5 | 1.987 | 5.961 | 161.11 |
| 3:00 AM | 63 | 1.976 | 5.929 | 160.24 |
| | 62.5 | 1.966 | 5.897 | 159.38 |
| 4:00 AM | 62 | 1.955 | 5.865 | 158.52 |
| | 61.5 | 1.945 | 5.834 | 157.67 |
| 5:00 AM | 61 | 1.934 | 5.802 | 156.82 |
| | 60.5 | 1.924 | 5.771 | 155.97 |
| 6:00 AM | 60 | 1.913 | 5.740 | 155.13 |
| | 59.5 | 1.903 | 5.709 | 154.29 |
| 7:00 AM | 59 | 1.893 | 5.678 | 153.46 |
| | 58.5 | 1.882 | 5.647 | 152.63 |
| 8:00 AM | 58 | 1.872 | 5.617 | 151.81 |
| | 57.5 | 1.862 | 5.587 | 150.99 |
| 9:00 AM | 57 | 1.852 | 5.557 | 150.18 |
| | 56.5 | 1.842 | 5.527 | 149.37 |
| 10:00 AM | 56 | 1.832 | 5.497 | 148.56 |
| | 55.5 | 1.822 | 5.467 | 147.76 |
| 11:00 AM | 55 | 1.813 | 5.438 | 146.96 |
| | 54.5 | 1.803 | 5.408 | 146.17 |
| NOON | 54 | 1.793 | 5.379 | 145.38 |
| | 53.5 | 1.783 | 5.350 | 144.60 |
| 1:00 PM | 53 | 1.774 | 5.321 | 143.82 |
| | 52.5 | 1.764 | 5.293 | 143.04 |
| 2:00 PM | 52 | 1.755 | 5.264 | 142.27 |
| | 51.5 | 1.745 | 5.236 | 141.51 |
| 3:00 PM | 51 | 1.736 | 5.208 | 140.74 |
| | 50.5 | 1.726 | 5.179 | 139.98 |
| 4:00 PM | 50 | 1.717 | 5.151 | 139.23 |
| | 49.5 | 1.708 | 5.124 | 138.48 |
| 5:00 PM | 49 | 1.699 | 5.096 | 137.73 |
| | 48.5 | 1.690 | 5.069 | 136.99 |

## DAY ONE PRE-CALIBRATION

| | Hours Before Cal | Decay Factor | Activity (GBq) | Activity (mCi) |
|---|---|---|---|---|
| 6:00 PM | 48 | 1.680 | 5.041 | 136.25 |
| | 47.5 | 1.671 | 5.014 | 135.52 |
| 7:00 PM | 47 | 1.662 | 4.987 | 134.79 |
| | 46.5 | 1.653 | 4.960 | 134.06 |
| 8:00 PM | 46 | 1.644 | 4.933 | 133.34 |
| | 45.5 | 1.636 | 4.907 | 132.62 |
| 9:00 PM | 45 | 1.627 | 4.880 | 131.90 |
| | 44.5 | 1.618 | 4.854 | 131.19 |
| 10:00 PM | 44 | 1.609 | 4.828 | 130.48 |
| | 43.5 | 1.601 | 4.802 | 129.78 |
| 11:00 PM | 43 | 1.592 | 4.776 | 129.08 |
| | 42.5 | 1.583 | 4.750 | 128.38 |
| MIDNIGHT | 42 | 1.575 | 4.725 | 127.69 |
| | 41.5 | 1.566 | 4.699 | 127.00 |
| 1:00 AM | 41 | 1.558 | 4.674 | 126.32 |
| | 40.5 | 1.550 | 4.649 | 125.64 |
| 2:00 AM | 40 | 1.541 | 4.624 | 124.96 |
| | 39.5 | 1.533 | 4.599 | 124.29 |
| 3:00 AM | 39 | 1.525 | 4.574 | 123.62 |
| | 38.5 | 1.516 | 4.549 | 122.95 |
| 4:00 AM | 38 | 1.508 | 4.525 | 122.29 |
| | 37.5 | 1.500 | 4.500 | 121.63 |
| 5:00 AM | 37 | 1.492 | 4.476 | 120.97 |
| | 36.5 | 1.484 | 4.452 | 120.32 |
| 6:00 AM | 36 | 1.476 | 4.428 | 119.67 |
| | 35.5 | 1.468 | 4.404 | 119.02 |
| 7:00 AM | 35 | 1.460 | 4.380 | 118.38 |
| | 34.5 | 1.452 | 4.357 | 117.74 |
| 8:00 AM | 34 | 1.444 | 4.333 | 117.11 |
| | 33.5 | 1.437 | 4.310 | 116.48 |
| 9:00 AM | 33 | 1.429 | 4.286 | 115.85 |
| | 32.5 | 1.421 | 4.263 | 115.23 |
| 10:00 AM | 32 | 1.413 | 4.240 | 114.60 |
| | 31.5 | 1.406 | 4.217 | 113.99 |
| 11:00 AM | 31 | 1.398 | 4.195 | 113.37 |
| | 30.5 | 1.391 | 4.172 | 112.76 |
| NOON | 30 | 1.383 | 4.150 | 112.15 |
| | 29.5 | 1.376 | 4.127 | 111.55 |
| 1:00 PM | 29 | 1.368 | 4.105 | 110.96 |
| | 28.5 | 1.361 | 4.083 | 110.35 |
| 2:00 PM | 28 | 1.354 | 4.061 | 109.75 |
| | 27.5 | 1.346 | 4.039 | 109.16 |
| 3:00 PM | 27 | 1.339 | 4.017 | 108.57 |
| | 26.5 | 1.332 | 3.996 | 107.99 |
| 4:00 PM | 26 | 1.325 | 3.974 | 107.40 |
| | 25.5 | 1.318 | 3.953 | 106.83 |
| 5:00 PM | 25 | 1.310 | 3.931 | 106.25 |
| | 24.5 | 1.303 | 3.910 | 105.68 |

# DAY OF CALIBRATION

Calculation from Calibration (18:00 Eastern Time) to Assay Time

## DAY OF CALIBRATION

| | Hours Before Cal | Decay Factor | Activity (GBq) | Activity (mCi) |
|---|---|---|---|---|
| 6:00 PM | 24 | 1.296 | 3.889 | 105.11 |
| | 23.5 | 1.289 | 3.868 | 104.54 |
| 7:00 PM | 23 | 1.282 | 3.847 | 103.98 |
| | 22.5 | 1.275 | 3.826 | 103.42 |
| 8:00 PM | 22 | 1.269 | 3.806 | 102.86 |
| | 21.5 | 1.262 | 3.785 | 102.30 |
| 9:00 PM | 21 | 1.255 | 3.765 | 101.75 |
| | 20.5 | 1.248 | 3.745 | 101.20 |
| 10:00 PM | 20 | 1.241 | 3.724 | 100.66 |
| | 19.5 | 1.235 | 3.704 | 100.11 |
| 11:00 PM | 19 | 1.228 | 3.684 | 99.57 |
| | 18.5 | 1.221 | 3.664 | 99.04 |
| MIDNIGHT | 18 | 1.215 | 3.645 | 98.50 |
| | 17.5 | 1.208 | 3.625 | 97.97 |
| 1:00 AM | 17 | 1.202 | 3.605 | 97.44 |
| | 16.5 | 1.195 | 3.586 | 96.92 |
| 2:00 AM | 16 | 1.189 | 3.567 | 96.40 |
| | 15.5 | 1.182 | 3.547 | 95.88 |
| 3:00 AM | 15 | 1.176 | 3.528 | 95.36 |
| | 14.5 | 1.170 | 3.509 | 94.85 |
| 4:00 AM | 14 | 1.163 | 3.490 | 94.33 |
| | 13.5 | 1.157 | 3.472 | 93.83 |
| 5:00 AM | 13 | 1.151 | 3.453 | 93.32 |
| | 12.5 | 1.145 | 3.434 | 92.82 |
| 6:00 AM | 12 | 1.139 | 3.416 | 92.32 |
| | 11.5 | 1.132 | 3.397 | 91.82 |
| 7:00 AM | 11 | 1.126 | 3.379 | 91.32 |
| | 10.5 | 1.120 | 3.361 | 90.83 |
| 8:00 AM | 10 | 1.114 | 3.343 | 90.34 |
| | 9.5 | 1.108 | 3.325 | 89.85 |
| 9:00 AM | 9 | 1.102 | 3.307 | 89.37 |
| | 8.5 | 1.096 | 3.289 | 88.89 |
| 10:00 AM | 8 | 1.090 | 3.271 | 88.41 |
| | 7.5 | 1.084 | 3.253 | 87.93 |
| 11:00 AM | 7 | 1.079 | 3.236 | 87.46 |
| | 6.5 | 1.073 | 3.218 | 86.99 |
| NOON | 6 | 1.067 | 3.201 | 86.52 |
| | 5.5 | 1.061 | 3.184 | 86.05 |
| 1:00 PM | 5 | 1.056 | 3.167 | 85.59 |
| | 4.5 | 1.050 | 3.150 | 85.12 |
| 2:00 PM | 4 | 1.044 | 3.133 | 84.67 |
| | 3.5 | 1.039 | 3.116 | 84.21 |
| 3:00 PM | 3 | 1.033 | 3.099 | 83.75 |
| | 2.5 | 1.027 | 3.082 | 83.30 |
| 4:00 PM | 2 | 1.022 | 3.066 | 82.85 |
| | 1.5 | 1.016 | 3.049 | 82.41 |
| 5:00 PM | 1 | 1.011 | 3.033 | 81.96 |
| 6:00 PM | 0 | 1 | 3.000 | 81.08 |

# POST-CALIBRATION

Calculation from Calibration (18:00 Eastern Time) to Assay Time

## POST-CALIBRATION

| | Hours After Cal | Decay Factor | Activity (GBq) | Activity (mCi) |
|---|---|---|---|---|
| 6:00 PM | 0 | 1 | 3.000 | 81.08 |
| | 0.5 | 0.96460784 | 2.894 | 80.64 |
| 7:00 PM | 1 | 0.989244756 | 2.968 | 80.21 |
| | 1.5 | 0.98091059 | 2.962 | 79.78 |
| 8:00 PM | 2 | 0.979605187 | 2.936 | 79.35 |
| | 2.5 | 0.973328391 | 2.920 | 78.92 |
| 9:00 PM | 3 | 0.968080049 | 2.904 | 78.49 |
| | 3.5 | 0.962060007 | 2.889 | 78.07 |
| 10:00 PM | 4 | 0.957668111 | 2.873 | 77.65 |
| | 4.5 | 0.952584212 | 2.858 | 77.23 |
| 11:00 PM | 5 | 0.947368157 | 2.842 | 76.81 |
| | 5.5 | 0.942258796 | 2.827 | 76.40 |
| MIDNIGHT | 6 | 0.937178981 | 2.812 | 75.99 |
| | 6.5 | 0.932125662 | 2.796 | 75.58 |
| 1:00 AM | 7 | 0.927098392 | 2.781 | 75.17 |
| | 7.5 | 0.922180324 | 2.766 | 74.76 |
| 2:00 AM | 8 | 0.917128212 | 2.751 | 74.36 |
| | 8.5 | 0.91218291 | 2.737 | 73.96 |
| 3:00 AM | 9 | 0.907264274 | 2.722 | 73.56 |
| | 9.5 | 0.90237216 | 2.707 | 73.17 |
| 4:00 AM | 10 | 0.897506425 | 2.693 | 72.77 |
| | 10.5 | 0.892668827 | 2.678 | 72.38 |
| 5:00 AM | 11 | 0.887863524 | 2.664 | 71.99 |
| | 11.5 | 0.883066876 | 2.649 | 71.60 |
| 6:00 AM | 12 | 0.878304443 | 2.635 | 71.21 |
| | 12.5 | 0.873568486 | 2.621 | 70.83 |
| 7:00 AM | 13 | 0.868858064 | 2.607 | 70.45 |
| | 13.5 | 0.864173642 | 2.593 | 70.07 |
| 8:00 AM | 14 | 0.859513283 | 2.579 | 69.69 |
| | 14.5 | 0.8548785 | 2.565 | 69.31 |
| 9:00 AM | 15 | 0.850269008 | 2.551 | 68.94 |
| | 15.5 | 0.845684221 | 2.537 | 68.57 |
| 10:00 AM | 16 | 0.841124157 | 2.523 | 68.20 |
| | 16.5 | 0.836589681 | 2.510 | 67.83 |
| 11:00 AM | 17 | 0.832077061 | 2.496 | 67.47 |
| | 17.5 | 0.827589965 | 2.483 | 67.10 |
| NOON | 18 | 0.823126402 | 2.469 | 66.74 |
| | 18.5 | 0.818688022 | 2.456 | 66.38 |
| 1:00 PM | 19 | 0.814275515 | 2.443 | 66.02 |
| | 19.5 | 0.809884811 | 2.430 | 65.67 |
| 2:00 PM | 20 | 0.805517783 | 2.417 | 65.31 |
| | 20.5 | 0.801174302 | 2.404 | 64.96 |
| 3:00 PM | 21 | 0.796854242 | 2.391 | 64.61 |
| | 21.5 | 0.792557477 | 2.378 | 64.26 |
| 4:00 PM | 22 | 0.78826388 | 2.365 | 63.91 |
| | 22.5 | 0.784033327 | 2.352 | 63.57 |
| 5:00 PM | 23 | 0.779855494 | 2.339 | 63.23 |
| | 23.5 | 0.775680858 | 2.327 | 62.89 |
| 6:00 PM | 24 | 0.771418694 | 2.314 | 62.55 |

# THERASPHERE EX

**Table 2**
**Yttrium-90 Physical Decay Table**
**Half-Life 64.1 Hours**

| Hours | Fraction Remaining | Hours | Fraction Remaining | Hours | Fraction Remaining |
|---|---|---|---|---|---|
| -4 | 1.044 | 30 | 0.723 | 64 | 0.501 |
| -2 | 1.022 | 32 | 0.707 | 66 | 0.490 |
| 0* | 1.000 | 34 | 0.692 | 68 | 0.479 |
| 2 | 0.979 | 36 | 0.678 | 70 | 0.469 |
| 4 | 0.958 | 38 | 0.663 | 72 (Day 3) | 0.459 |
| 6 | 0.937 | 40 | 0.649 | 96 (Day 4) | 0.354 |
| 8 | 0.917 | 42 | 0.635 | 120 (Day 5) | 0.273 |
| 10 | 0.898 | 44 | 0.621 | 144 (Day 6) | 0.211 |
| 12 | 0.878 | 46 | 0.608 | 168 (Day 7) | 0.163 |
| 14 | 0.860 | 48 (Day 2) | 0.595 | 192 (Day 8) | 0.125 |
| 16 | 0.841 | 50 | 0.582 | 216 (Day 9) | 0.097 |
| 18 | 0.823 | 52 | 0.570 | 240 (Day 10) | 0.075 |
| 20 | 0.806 | 54 | 0.558 | 264 (Day 11) | 0.058 |
| 22 | 0.788 | 56 | 0.546 | 288 (Day 12) | 0.044 |
| 24 (Day 1) | 0.771 | 58 | 0.534 | | |
| 26 | 0.755 | 60 | 0.523 | | |
| 28 | 0.739 | 62 | 0.511 | | |

*Calibration Time

https://btgplc.com/en-US/TheraSphere/TheraSphere-iDOC


Monday (-3)
1800 EST

SIR-Spheres®
Y-90 resin microspheres

SS Cal Time (0)**
Thursday
1800 EST

Monday (+8)
1200EST

Friday (+12)
1200EST

Time

Friday (+1)
1800 EST

TS Cal Time(0)
Sunday
1200EST

TheraSphere®

# SO WHAT IS CALIBRATION?

## Therasphere:

Sunday 1200 EST
(concept: made once a week)

## Sirsphere:

Day of Admin 1800
(concept: made to order)


# CONTRALATERAL HYPERTROPHY

REVIEW ARTICLE

# A systematic review of contralateral liver lobe hypertrophy after unilobar selective internal radiation therapy with Y90

Jin-Yao Teo[1], John C. Allen Jr.[2], David C. Ng[3], Su-Pin Choo[4], David W.M. Tai[4], Jason P.E. Chang[5], Foong-Khoon Cheah[6], Pierce K.H. Chow[1,2] & Brian K.P. Goh[1,2]

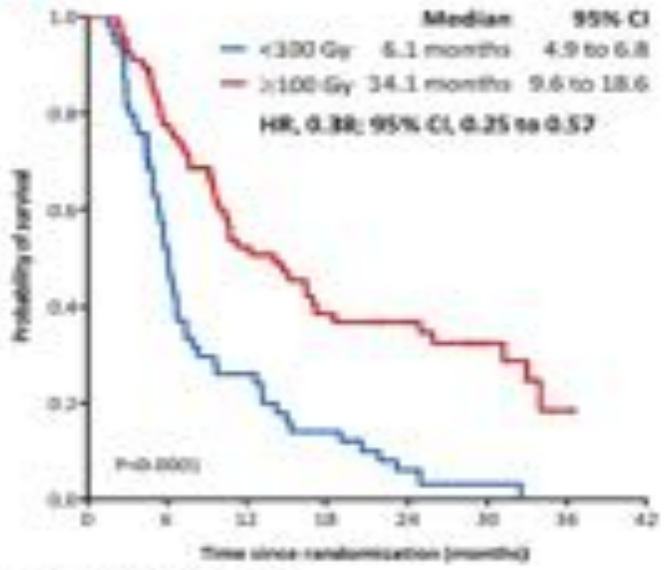
| Paper | Number of patients | Age | Pathology treated | SIRT modality | Site of Y90 delivery | Number of treatment sessions | Method of volume measurement | Time to measurement | Percentage hypertrophy (mean/median (range)) |
|---|---|---|---|---|---|---|---|---|---|
| Ahmadzadehfar *et al.* 2013 Germany[13] | 24 | Median 53 (range 44–78) | Metastatic disease (mixed) 17 – bi-lobar | Resin microspheres | Right lobe | Single | FDG PET/CT | Mean 44 days, median 36 days | Mean 47%, median 34% Only right lobe disease – mean 57%, median 70% |
| Edeline *et al.* 2013 France[14] | 34 | Not stated | Primary – HCC | 30 Glass, 4 resin microspheres | 23 right, 11 left | Single | CT | 3 months Not stated | Mean 29% Mean 42% (maximal) |
| Vouche *et al.* 2013 USA[15] | 83 | Median 68 (range 36–89) | 67 HCC, 8 IHC, 8 CRC mets | Glass microspheres | Right lobe | Single | MRI/CT | 1- >9 months | Median overall 26% (–14–86) Median 45% at 9 months (5–186) |
| Theysohn *et al.* 2013 Germany[16] | 45 | Mean 71.9 | HCC | Glass microspheres | Right lobe | Single | CT | 6 Months | Mean 30.8% |
| Fernandez-Ros *et al.* 2013 Spain[17] | 83 | Median 66 | 52 HCC, 4 IHC, 13 CRC mets, 14 others | Resin microspheres | 66 right, 17 left | Single | CT/MRI | 26 weeks | Mean 45% |
| Garlipp *et al.* 2013 Germany, France[18] | 26 | Mean 59.2 | Metastatic disease (mixed) | Resin microspheres | Right lobe | Single | MRI | Median 46 days (27–79 days) | Mean 29%, median 25.3% |
| Teo *et al.* 2014 Singapore[19] | 17 | Median 72 (range 42–78) | HCC | Resin microspheres | Right lobe | Single | CT | Median 5 months | Mean 34.2% |

# CONTRALATERAL HYPERTROPHY:

- Hypertrophy is identified retrospectively
- Activity determination method not formalized
- Intent to treat has not been done
- Dose modulation studies not performed

# OS

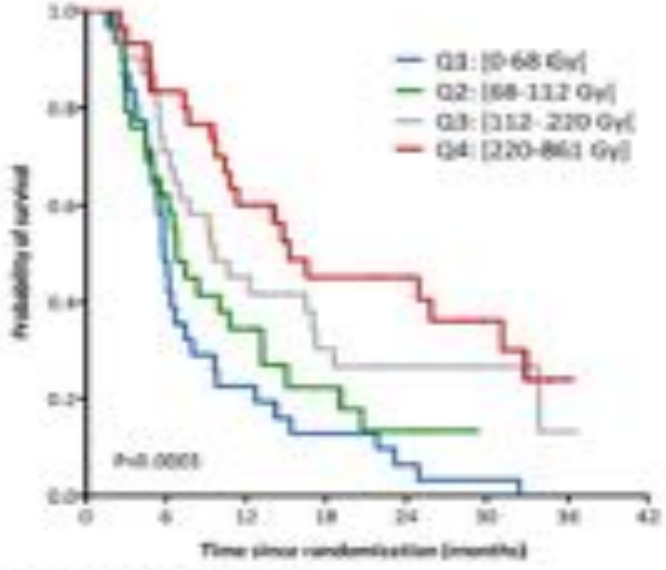
## SARAH




Number at risk (number censored)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| <100 Gy | 34 (0) | 28 (0) | 24 (0) | 7 (1) | 3 (1) | 1 (2) | 0 (2) |
| ≥100 Gy | 67 (0) | 52 (0) | 34 (1) | 22 (3) | 18 (8) | 9 (13) | 2 (19) | 0 (21) |

Median OS
6.1 months [95%CI 4.9–6.8] < 100 Gy
14.1 months [95%CI 9.6–18.6] ≥ 100 Gy




Number at risk (number censored)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Q1 | 31 (0) | 25 (0) | 7 (0) | 4 (0) | 2 (0) | 1 (0) | 0 (0) |
| Q2 | 29 (0) | 18 (0) | 10 (0) | 5 (1) | 0 (1) | 0 (1) | |
| Q3 | 31 (0) | 22 (0) | 13 (1) | 8 (1) | 5 (4) | 3 (6) | 1 (7) | 0 (8) |
| Q4 | 30 (0) | 25 (0) | 18 (0) | 12 (1) | 11 (1) | 6 (6) | 1 (9) | 0 (10) |

Median OS
5.8 months [95% CI 4.9–7.4] Q1: < 68 Gy
15.2 months [95% CI 10.4–31.2] Q4: ≥ 220 Gy

EASL THE INTERNATIONAL LIVER CONGRESS™ 2017

# DOSIMETRY: THE NEXT GENERATION

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Home › Products › Dosimetry › PLANET® Dose

## PLANET® Dose

Personalized 3D dosimetry for Targeted Radionuclide Therapy using 90Y-microspheres or 177Lu

PLANET® Dose provides pre & post-implementation dosimetry, estimation of time-integrated activity, allows the possibility of comparing between treatment planning and validation control dose maps, and the consolidation of multi-treatment stages.

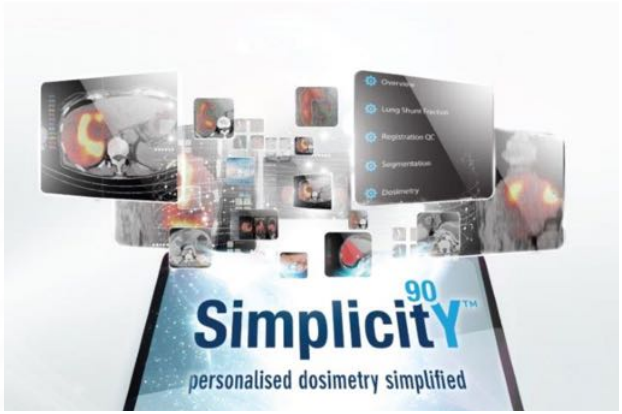
It offers a complete integration of oncology features (PLANET Onco), with versatile and high performance solutions for the whole clinical workflow.

**90Yttrium Microspheres**

- Pre-implantation dosimetry based on 99Tcm-MAA-SPECT exam (MacroAggregate Albumin)
- Liver-lung shunt assessment
- Post-implantation dosimetry based on 90Y-microspheres-PET (or SPECT Bremsstrahlung) exam
- Voxel S-Values dose kernel convolution algorithm/Local Deposition Method
- Dose map comparison: treatment planning vs. *in vivo* control
- Consolidation of multi-treatment stages

**177Lutetium**

- Multi-time points elastic registration
- Automatic deformable propagation of VOI across times
- Residence time calculation
- Dose computation based on voxel-level analysis
- Voxel S-Values dose kernel convolution algorithm/Local Deposition Method
- Dosimetry comparison and consolidation of multi-treatment stages




MIRADA medical

11:32 LTE

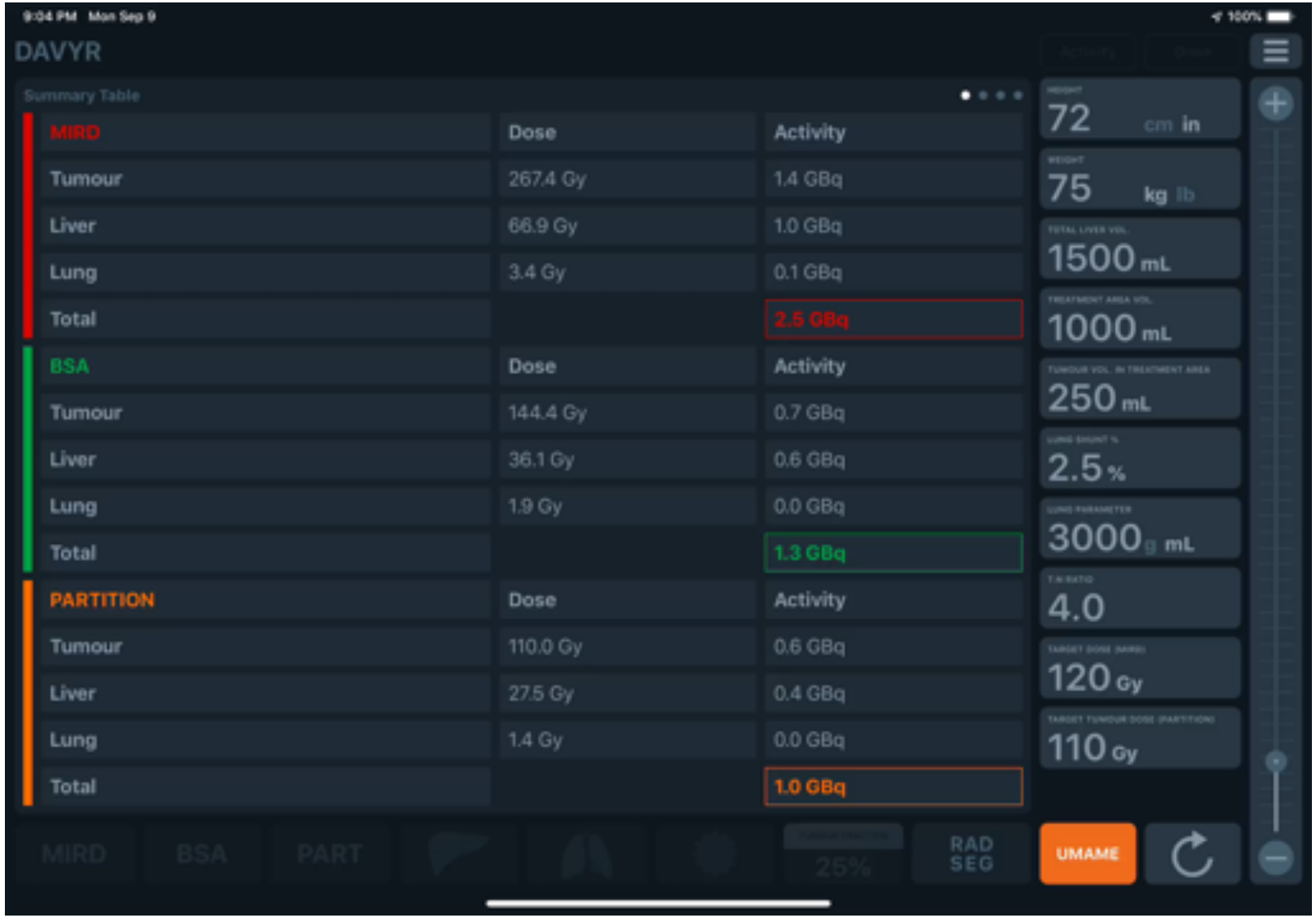
DAVYR

DOSIMETRY
ACTIVITY
VISUALIZER FOR
YTTRIUM-90
RADIOEMBOLIZATION

Now With
Radiation Segmentectomy

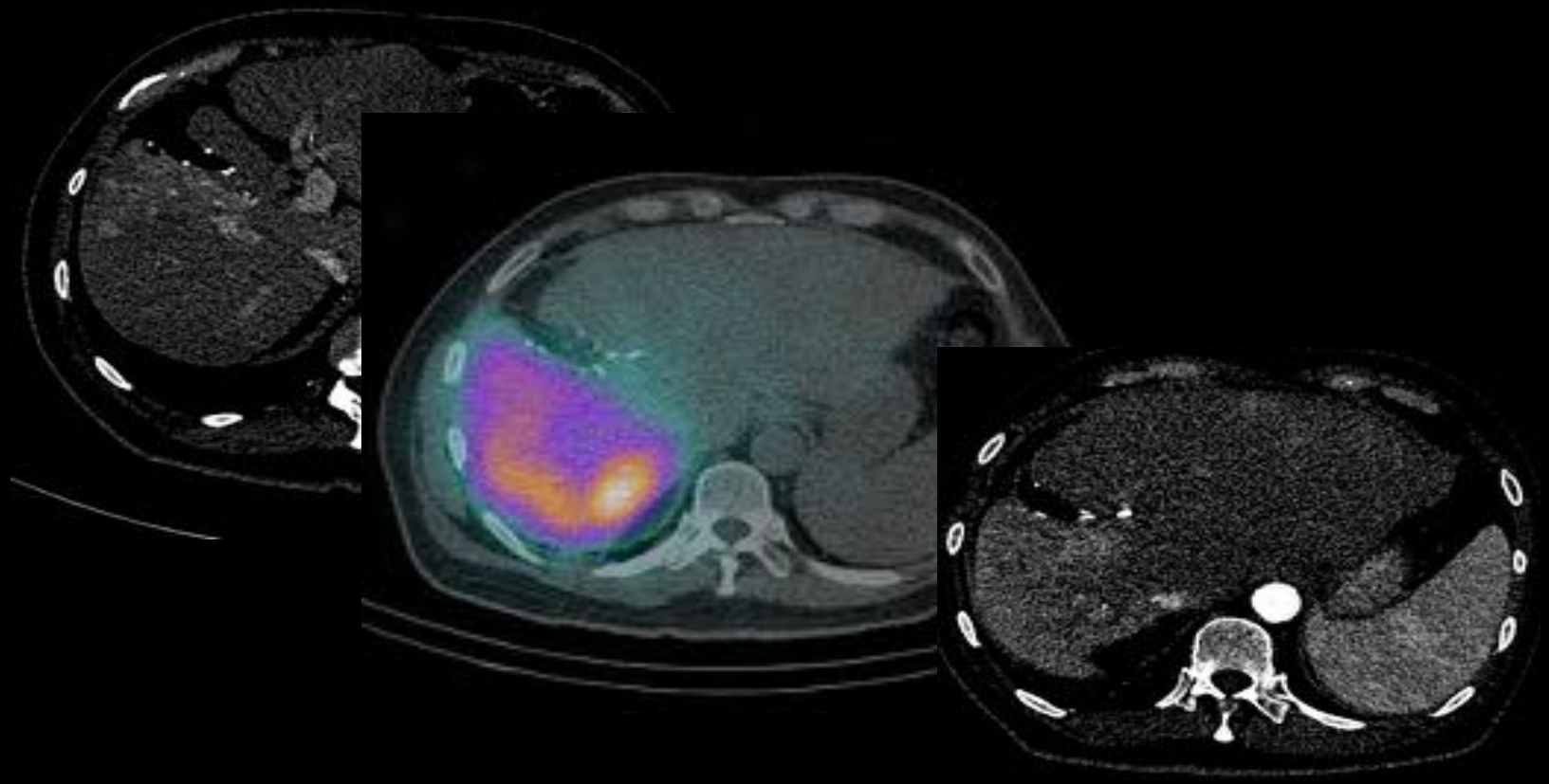
Vancouver IMAGING

# DAVYR Workflow Demo




- BSA, MIRD, and partition
- Dose estimation
- Exportable to PDF and CSV
- Built-in tutorials
- For iOS and Android
- Graphical functions available on iPad

# PARTITION MODEL
# RADIATION LOBECTOMY & HYPERTROPHY



DAVYR

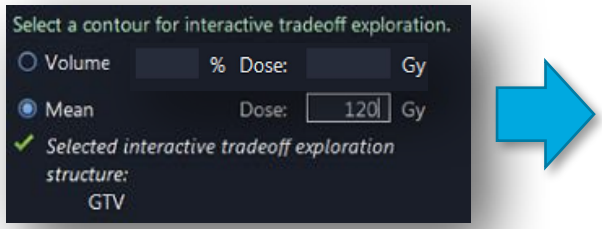
| MIRD | DOSE | ACTIVI... |
|---|---|---|
| TUMO... | 365.1... | 0.9 GBq |
| LIVER | 81.1 Gy | 1.4 GBq |
| LUNG | 2.2 Gy | 0.1 GBq |
| TOTAL | | 2.4 GBq |

| BSA | DOSE | ACTIVI... |
|---|---|---|
| TUMO... | 149.1 Gy | 0.4 GBq |
| LIVER | 33.1 Gy | 0.6 GBq |
| LUNG | 0.9 Gy | 0.0 GBq |
| TOTAL | | 1.0 GBq |

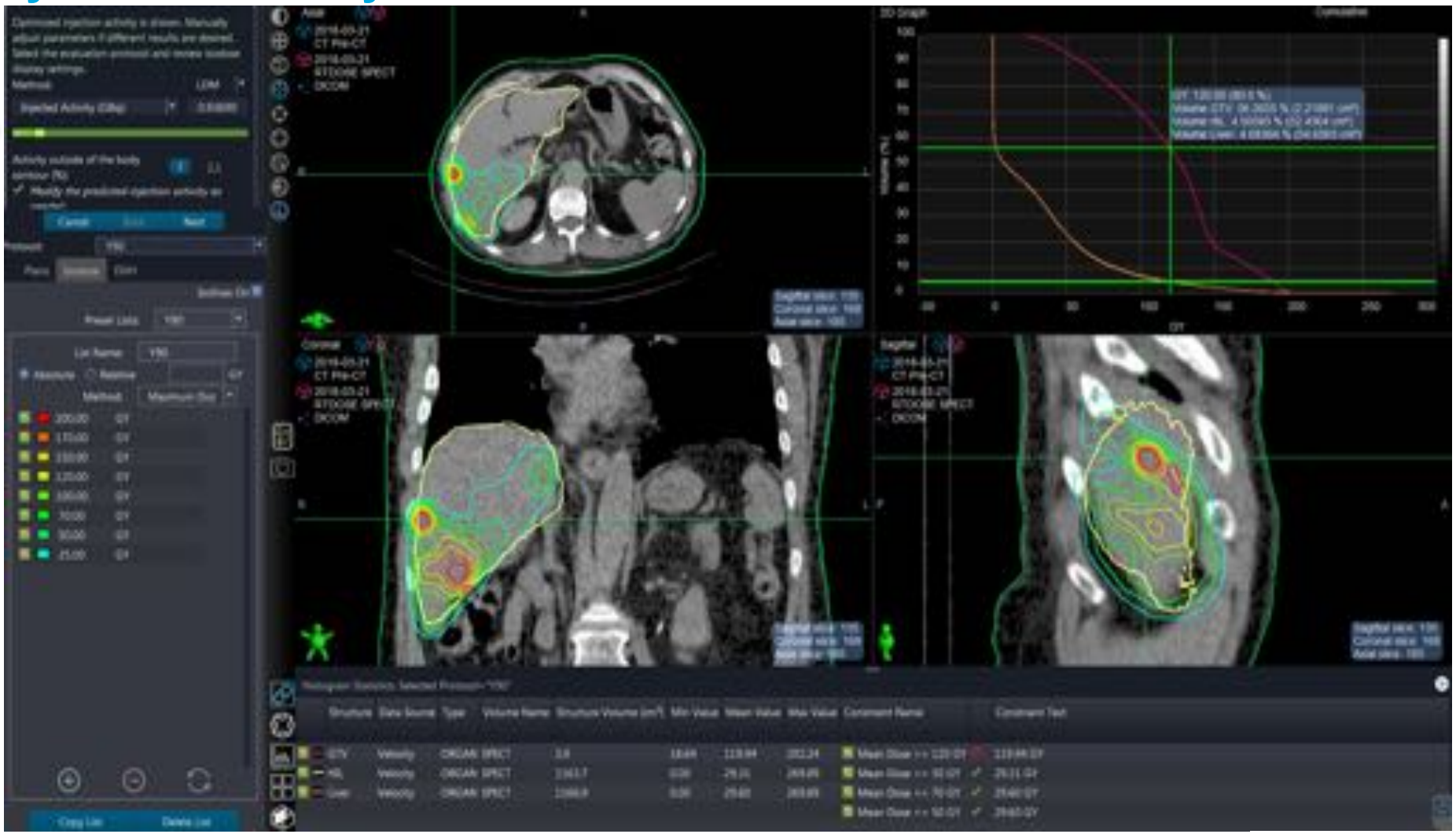
| Partition | DOSE | ACTIVI... |
|---|---|---|
| TUMO... | 315.0... | 0.8 GBq |
| LIVER | 70.0 Gy | 1.2 GBq |
| LUNG | 1.9 Gy | 0.1 GBq |
| TOTAL | | 2.0 GBq |

# RapidSphere™ Exploration (Varian)

## Interactive dosimetry of Y-90 activity




- Retrospectively optimize activity to desired dose
- Explore injected activity effects on dose distribution
- Understand dose response to drive research



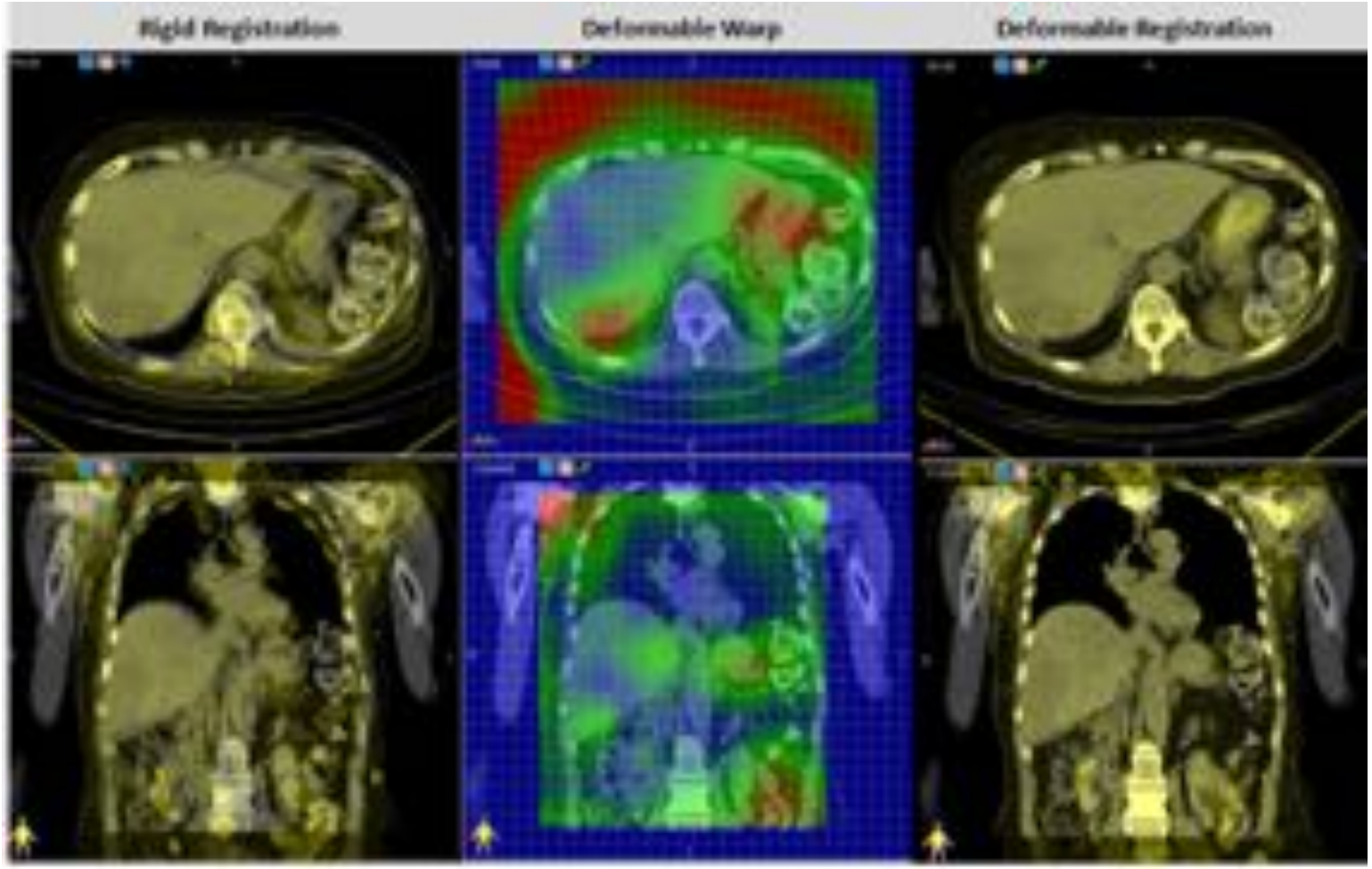


**Work in progress: not available for sale or guarantee of commercialization.**

# Deformable Dose Mapping and Dose Summation

## Typically 4 procedures to treat whole liver, which requires deformable dose summation

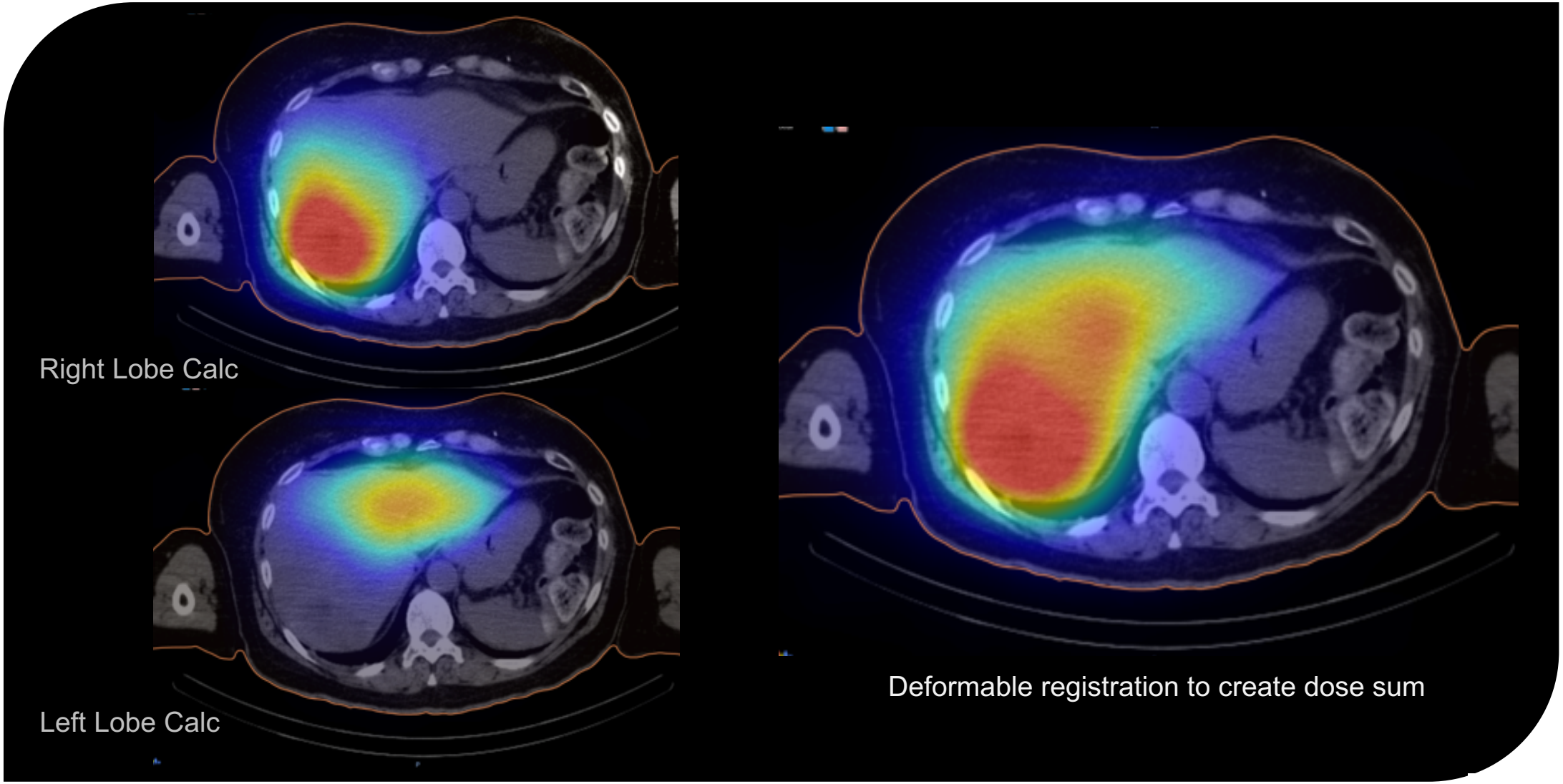
- Can treat unilobar (left or right), whole liver, or focal lesion
- Goal of completing treatment in 6-8 weeks (often 4 procedures to treat whole liver)
- Registration of the 2 independent SPECT-CT-Dose datasets will be implemented using non-rigid BSpline technique with mutual information metric



# RapidSphere Workflow Demo

# Treatment Delivery: RapidSphere

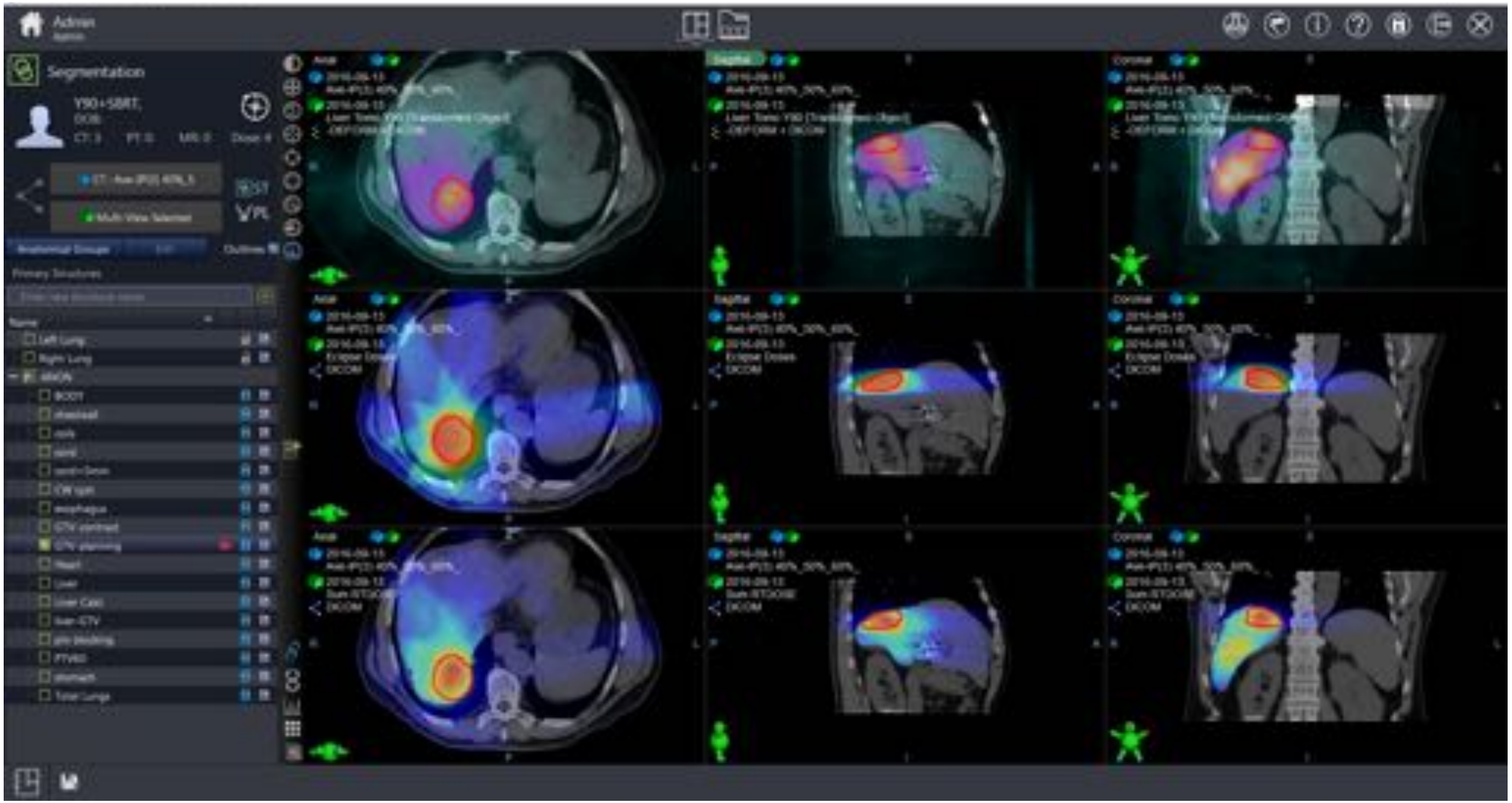
## Example of composite dose distribution of Y-90 microsphere therapy






**Courtesy of Emory University.**

# Y-90 Dose + SBRT Dose Deformable Summation: RapidSphere




Y90 dose

SBRT dose

Summed Y90 & SBRT dose

# SUMMARY

1. Activity calculators based on safety
2. Partition based on segmentation
3. DVH and voxel based on personalized DOSIMETRY