SNMMI Value Initiative
MIRD COMMITTEE
MEDICAL INTERNAL RADIATION DOSE

MIRD soft

MIRD pvc

A recovery coefficient-based partial-volume correction tool

User Manual

Version 1.0

Memorial Sloan Kettering Cancer Center

Legal Notice

Disclosure

The MIRDpvc software aids a user in performing PVC on image-derived quantitative metrics in PET and SPECT imaging and is intended for educational and research use only. MIRDpvc has not been approved by the U.S. Food and Drug Administration (FDA) and is not intended for clinical use or use as a medical device. MIRDpvc and any results generated from the use thereof are not substitutes for medical diagnosis, advice, and/or treatment of specific medical conditions. A physician should always be consulted for any health problem or medical condition

Acknowledgements

Project lead: Harry Marquis (MSKCC)

Contributors: Adam Kesner (MSKCC), Ross Schmidtlein (MSKCC), Gunjan Kayal (MSKCC), Lukas Carter (MSKCC), Juan Ocampo Ramos (MSKCC), Robin de Nijs (CUH), Dale Bailey (RNSH), Pablo Minguez Gabina (HUC), Johan Gustafsson (Lund University)

We gratefully acknowledge funding from the NIH/NCI Cancer Center Support Grant P30 CA008748 and NIH U01 EB028234.
We acknowledge guidance and support from the Society of Nuclear Medicine and Molecular Imaging Committee on Medical Internal Radiation Dose, and the SNMMI organization. The authors would also like to thank Dr. Kathy Willowson, Dr. Yuni Dewaraja, Dr. Stephen Graves, Dr. John Dickson, for the various productive conversations had regarding RCs, RC-PVC and software functionality.

Table of Contents

Overview

MIRDpvc is a freely available Excel-based software tool for partial-volume correction (PVC) in PET and SPECT imaging, developed as part of the MIRDsoft community dosimetry suite. MIRDpvc provides a practical, standardized workflow for RC-based PVC and is designed to promote reproducibility and accessibility across the nuclear medicine community. Key features of MIRDpvc include:

- Calibration using phantom data (e.g., NEMA spheres) or direct input of system spatial resolution.
- Implementation of the RECOVER-GM model, which enables shape-specific corrections based on ellipsoidal geometry.
- Support for conventional RC curve PVC, including two-parameter (2-PL) and three-parameter logistic (3-PL) models.
- MIRDpvc corrects for both spill-out and spill-in partial volume effects.
- A simple, single-screen interface with interactive calculations and graphical feedback.
- Built-in quality control tools to assess the suitability of image reconstruction protocols for PVC.
- Compatibility with other MIRDsoft tools (e.g., MIRDfit, MIRDcalc) for integrated absorbed dose estimation.

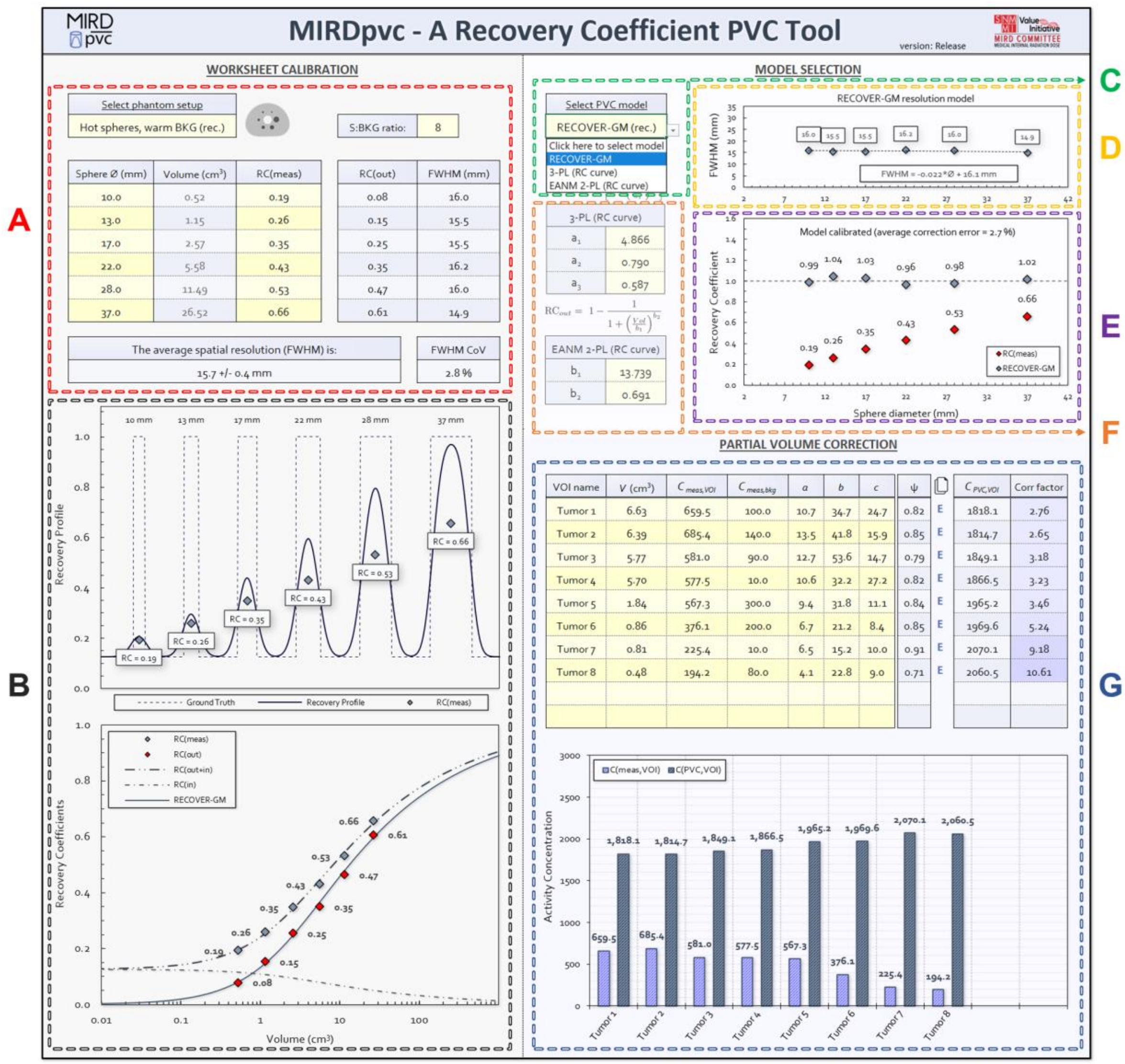


Figure 1: *MIRDpvc graphical use interface (GUI) showing the calibration module: Phantom setup and input RCs (A), display of input RCs and model RC curves (B). PVC module: Model selection (C), RECOVER-GM resolution model (D), PVC model test (E), 2-PL and 3-PL RC curve input parameters (F), PVC input table and output results display (G).*

The workflow of the MIRDpvc software can be distinctly categorized into two main steps: 1) worksheet and PVC model calibration, and 2) performing partial volume correction. A workflow schematic is shown in Figure 2 below:

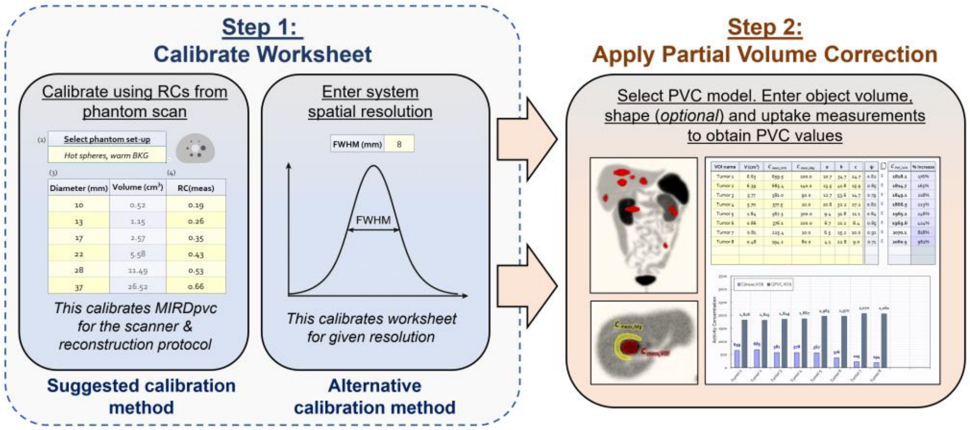


***Figure 2**. MIRDpvc workflow showing the worksheet calibration steps. Step 1: Calibrate worksheet using RCs from a phantom scan or input a known system spatial resolution. Step 2: Selection of PVC model and enter object volume, shape, and uptake measurements to obtain partial-volume corrected values.*

An important thing to be aware of when navigating the worksheet is that most input cells have tooltips embedded in the column headers. To activate these, just hover your mouse over the column header and a tooltip will appear. These tips help the user understand the format of the various input data, how to calibrate the worksheet and various models, as well as how to interpret the various outputs.

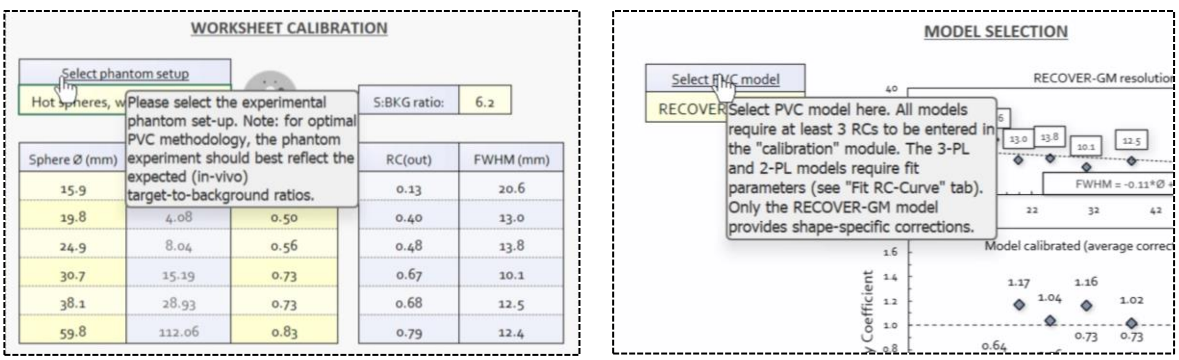


***Figure 3**. MIRDpvc has tooltips in column headers, helping you navigate the worksheet.*

In addition to tooltip hints, the worksheet will guide you into expected input data formats should you enter in incorrect values or datatypes:

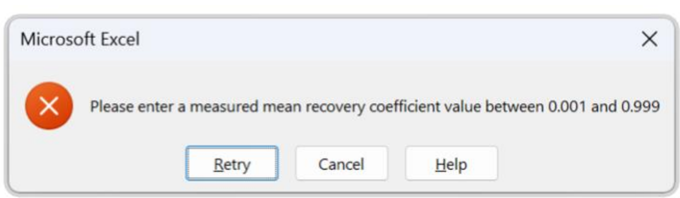


***Figure 4.** Example of error message when incompatible data is input.*

Worksheet calibration

MIRDpvc requires initial calibration before performing partial-volume correction (PVC). Calibration is achieved by entering measured recovery coefficients (RC_{meas}) from phantom studies or by specifying the system's spatial resolution directly. This flexibility allows MIRDpvc to accommodate a range of clinical and research setups. There are 3 options for worksheet calibration using phantom RCs:

1. Hot spheres with warm background:
2. Hot spheres, no background:
3. Cold spheres with hot background:

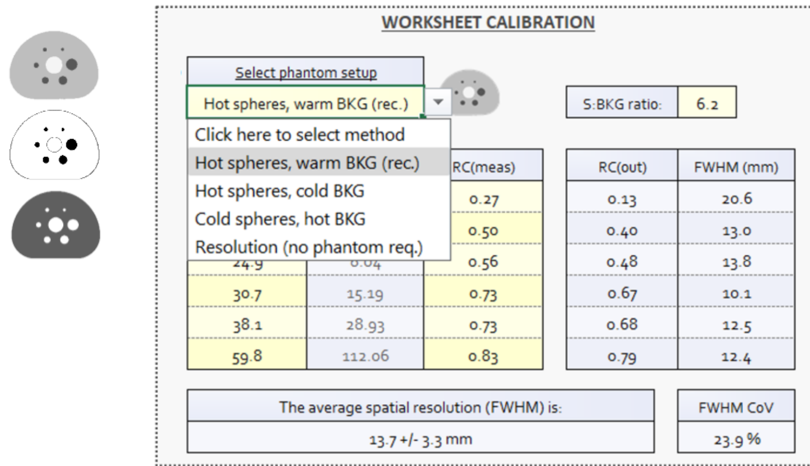


Figure 5*. Worksheet calibration options using phantom RCs from different experimental setups: 1) Hot spheres, warm background (recommended), 2) Hot spheres with cold background, 3) Cold spheres with hot background. Users can also calibrate the worksheet with 4) a known system spatial resolution (no phantom experiment required).*

As an alternative to phantom-based calibration, users may specify the system's spatial resolution directly (full width at half maximum, FWHM, in mm), bypassing the need for measured RCs. Calibration using a phantom is recommended, but the user specified FWHM option permits users to bypass the RC-based calibration if the system resolution is known and assumed to be relatively uniform. The next sections briefly describe each of the calibration options in more detail.

Calibration using phantom recovery coefficients

MIRDpvc calibration is performed by entering measured recovery coefficients (RC(meas)) derived from phantom studies, allowing the worksheet to be calibrated for a specific scanner/acquisition protocol/reconstruction protocol used. The software supports several phantom configurations: (1) hot spheres in a warm background, (2) hot spheres in air without background activity, and (3) cold spheres embedded in a hot background. These phantom acquisitions are routinely employed in quality assurance workflows and include standardized phantoms such as the NEMA IEC body phantom and the ACR SPECT phantom.

For hot-sphere configurations (cases 1 and 2), RC(meas) is defined as the ratio of the activity concentration measured in each sphere to the known true activity concentration [C(meas,sphere))/C(true,sphere)]. For cold-sphere setups (case 3), RC(meas) corresponds to the ratio of the measured signal within the cold sphere to the true (or measured) background activity concentration [C(meas,sphere)/C(meas,BKG)]; thereby, the cold sphere RC(meas) essentially describes spill-in partial volume effects. Calibration proceeds by entering the sphere diameters and associated RC(meas) values into the worksheet (Figure 1A). The corresponding spill-out recovery coefficients RC(out) are then computed using the input sphere-to-background ratio, as shown in Equation 1.

$$\mathrm{RC}_{out} = \frac{SBR \times \mathrm{RC}_{meas} - 1}{SBR - 1} \quad (1)$$

where SBR is the sphere-to-background ratio. Note that the spill-out recovery coefficient (RC_{out}) is similar to the contrast recovery coefficient (CRC) and can be thought of as a background-corrected recovery coefficient. The resolution (FWHM in mm) is then automatically calculated using the Resolution Equivalent Recovery Coefficient (RERC) equation (see MIRD pamphlet No. 32 for more details [1]) shown in Equation 2:

$$FWHM = \frac{R}{3\beta}\left[\left(\frac{1}{1-\mathrm{RC}_{out}}\right)^{\frac{1}{L}} - 1\right]^{-\frac{1}{\gamma}} \approx\ (2.01625 \times R)[(1-\mathrm{RC}_{out})^{-2.8967} - 1]^{-0.3487} \quad (2)$$

where β=0.1653, γ=2.8679, and L=0.3452, are fixed parameters derived from an empirical fit to simulated RCs, and R is the sphere radius. The RERC equation calculates the Gaussian FWHM required to produce the measured RC (RC_{meas}), given the known sphere radius and SBR. The right-hand side of Equation 2 is a simplified form of the RERC equation, included for ease of external implementation, validation, or testing. The RERC equation is used to calculate the spatial resolution (FWHM, in mm) corresponding to each measured RC that is input into the worksheet. Once at least three FWHM values have been generated (corresponding to 3 input RCs), the worksheet is now calibrated (provided the input RCs are good data and pass the worksheet's error catching features). One quality check that occurs is to ensure that the coefficient of variation (CoV) across the FWHM values does not exceed 50 %, which is intended to inform the user when RC-based PVC may not be appropriate—for example, in cases of high variability, this may indicate unpredictable convergence.

Once the worksheet has been calibrated, the user can now proceed to PVC model selection and further calibration of the 2-PL and 3-PL models if desired. Note that RECOVER-GM model is automatically calibrated (provided it is compatible with the entered data), and so this is the model we recommend using.

Calibration using a known system resolution

As mentioned earlier, MIRDpvc can be calibrated by simply entering in a known spatial resolution in terms of FWHM (in mm). This is the quickest way to calibrate MIRDpvc, where the worksheet can be calibrated and ready for partial volume correction in just a couple of clicks. If this calibration option ("Resolution (no phantom req.)") is selected, an input box will appear where you can enter the FWHM, as shown below in Figure 6:

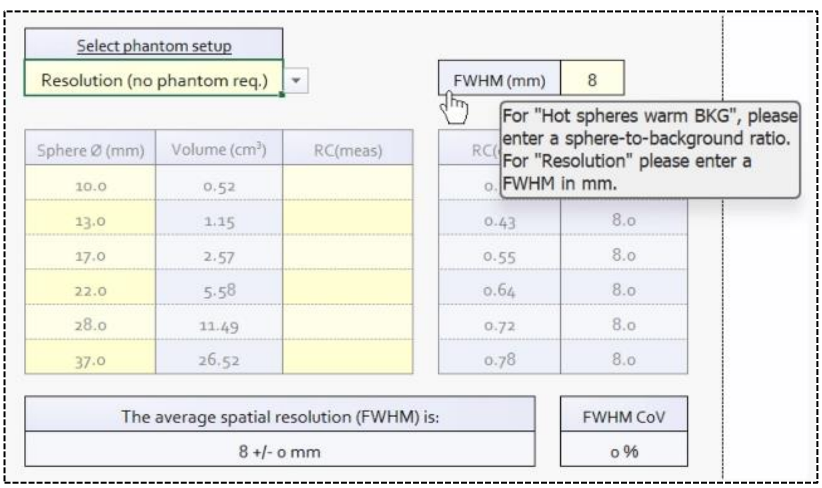


***Figure 6**. MIRDpvc calibrated using a known system spatial resolution (FWHM in mm).*

Model Selection and RC Curve Calibration

Once the worksheet has been calibrated using either phantom-derived RC values or input system resolution, the user proceeds to model selection. MIRDpvc offers 3 Recovery Coefficient based PVC models: RECOVER-GM, the two-parameter logistic (2-PL) model, and the three-parameter logistic (3-PL) model. The user selects the desired model from a dropdown menu, as shown in Figure 7:

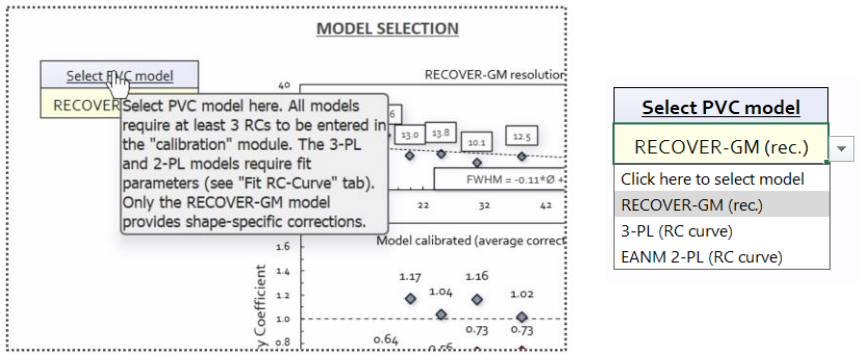


Figure 7: *PVC model selection drop-down menu.*

When input RCs are used to calibrate the worksheet, the user has the option to use any of the 3 models shown in the drop-down list. When MIRDpvc is calibrated with a user-specified system resolution, only the RECOVER-GM model will be available.

RECOVER-GM: The RECOVER-GM model uses the FWHM values generated from the input RCs and fits a least squares line of best fit (LoBF) as a function of sphere diameter (*FWHM=m×Diameter+b*) to the data; this LoBF characterizes the PET or SPECT reconstruction protocol corresponding to the input RC data which is subsequently applied during PVC. It is worth noting that the RECOVER-GM resolution model automatically generates a sigmoid-shaped RC curve similar to a conventional 2-parameter logistic function RC-curve. An example of the RECOVER-GM resolution model, and the RC curve it generates, is shown in Figure 8:

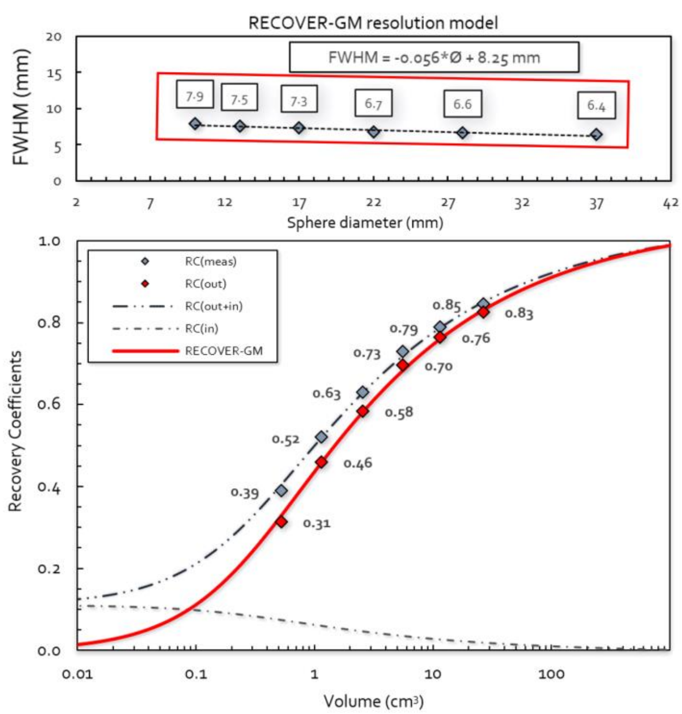


Figure 8*. The RECOVER-GM resolution model produces spill-out RC curve akin to conventional logistic function RC curves, but without the need for iterative curve fitting procedures.*

2-PL & 3-PL RC curves: The 2-PL and 3-PL logistic models are more traditional RC-curve methods, calibrated to phantom data and apply only spherical corrections. Model parameters can be fit within MIRDpvc using the "Fit RC-Curve" tab, though pre-fitted parameters can also be entered directly if known. The RC-curves are fit to the RC(out) values calculated from RC(meas), as described earlier (see Eq. 1). The "Fit RC-Curve" tab is shown below in Figure 9:

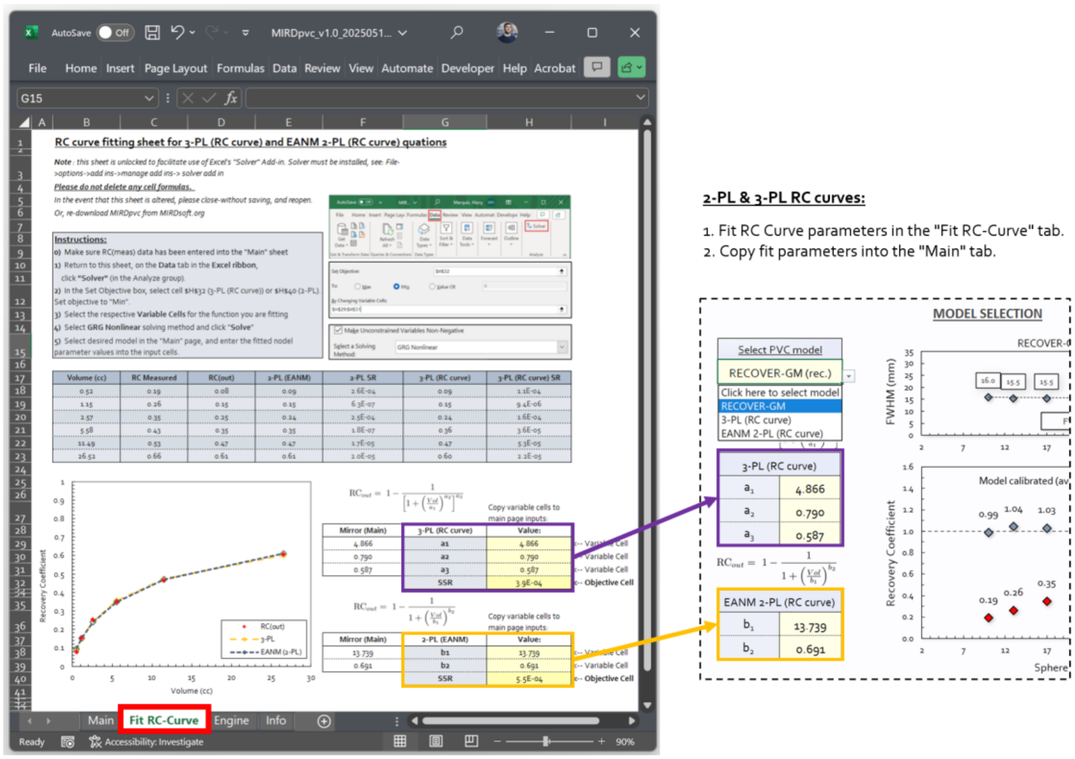


Figure 9: *The conventional RC curve model (2-PL and 3-PL) parameters can be fit in the worksheet "Fit RC-Curve" tab. Once the parameters have been fit, the user must 1) select the desired model using the drop-down menu, and 2) enter the fitted parameters into the respective input cells.*

Model accuracy test: Once a PVC model has been selected and the model is calibrated, the worksheet tests the selected model using the input RC data as a validation check. This step essentially indicates how good a fit your model is to the input RC data. An example of this is shown below in Figure 10:

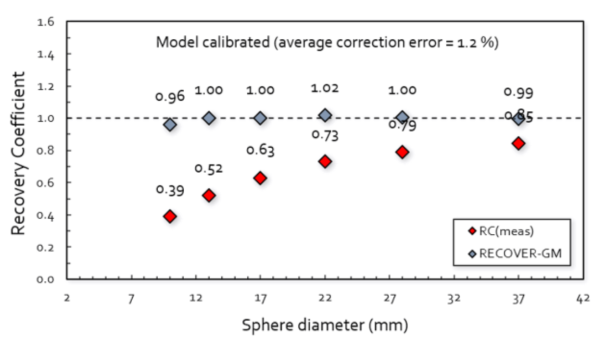


Figure 10: *Once a model has been selected the worksheet will automatically test how well it performs at correcting the input RCs. This essentially indicates how well the selected (and calibrated) model fits the input data.*

If the model passes this check the worksheet is now ready to perform PVC. Note that if the input data does not pass the error catching checks, the user can relax these restrictions in the Engine Tab (Cells U23:U25) as shown in Figure 11:

(2) variables and flags

Parameters - global variables

Row	Global variable function	Variable name	Variable value
5	Sphere to background ratio - phantom	sbr_phant	10000000000
6	beta	beta	0.17
7	gamma	gamma	2.87
8	Luke	luke	0.35
17	FWHM to Sigma conversion	fwhm2sigma	2.35
18	MIRDpvc version	MIRDpvc_version	Release
19	selected model RC diff		0.00
20	Allowed percent difference (model fit to data)	RD_Limit	20
21	Smallest allowable RC (magnitude of correction)	smallest_RC	0.05
22	FWHM CoV limit	COV_limit	50
23	**[Editable]** Allowed percent difference (model fit to data)	[Edit -->]	20
24	**[Editable]** Smallest allowable RC (magnitude of correction)	[Edit -->]	0.05
25	**[Editable]** FWHM CoV limit	[Edit -->]	50

Figure 11: *The user can change various restrictions by modifying the values in cells U23:U25 in the Engine tab: U23 controls how well the model has to fit the data, U24 controls the largest allowable corrections (0.05 corresponds to a correction factor of 20), U25 controls the largest allowable coefficient of variation amongst the FWHM values calculated from the input RCs.*

Partial Volume Correction

Partial volume correction is performed using the table shown in Figure 12. In order to perform PVC, the user must input the object volume and measured activity concentration (or SUV) within the volume of interest (VOI). Optional inputs are the measured background activity concentration (local to the object VOI) to account for spill-in, and—when using the RECOVER-GM model—optional ellipsoid shape parameters. Figure 12 shows an example of the PVC table and display when using the RECOVER-GM model.

PARTIAL VOLUME CORRECTION

VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{meas,bkg}$	a	b	c	ψ		$C_{PVC,VOI}$	Corr factor
L Kidney	256.00	36.9	1.2	35.4	10.9	10.9	0.83	E	42.7	1.16
R Kidney	198.00	38.5	1.5	8.4	9.3	40.1	0.76	E	45.9	1.19
L Parotid	25.40	34.4	4.3	9.3	8.1	3.5	0.85	E	46.6	1.35
R Parotid	27.80	32.8	5.6	10.6	32.2	27.2	0.82	E	44.0	1.34
Lesion 1	0.87	19.6	2.7	3.1	10.8	11.1	0.74	E	68.5	3.49
Lesion 2	1.30	22.6	5.5	3.7	21.2	15.4	0.63	E	70.1	3.10
Lesion 3	0.24	12.7	0.1	5.1	5.1	5.1	1.00	S	79.1	6.23

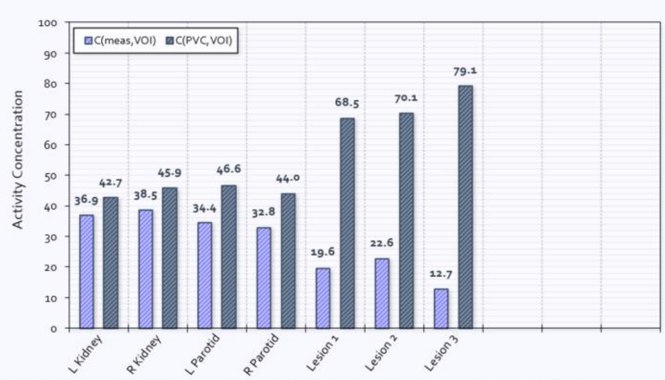


Figure 12: *PVC table and display when using the RECOVER-GM model (indicated by the fact that shape-specific corrections are enabled).*

Figure 13 describes the effect of various inputs in the PVC table:

VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{meas,bkg}$	a	b	c	ψ		$C_{PVC,VOI}$	Corr factor	
VOI 1	1.00	100.0	0.0	1.0	1.0	1.0	1.00	S	243.9	2.44	→(1) (a,b,c) = (1,1,1) = Sphere
VOI 2	1.00	100.0					1.00	S	243.9	2.44	→(2) If C(meas,BKG) = blank = 0 | If (a,b,c) = blank = (1,1,1) = Sphere
VOI 3	1.00	100.0	10.0	1.0	1.0	1.0	1.00	S	229.5	2.29	→(3) C(meas,BKG) = 10, C(PVC,VOI) is lower than the 0 BKG case in (1)
VOI 4	1.00	100.0	10.0	10.0	1.0	10.0	0.42	E	474.1	4.74	→(4) (a,b,c) = (10,1,10) = Ellispoid, → C(PVC,VOI) higher than in (4) and (1)
VOI 5	1.00	100.0	150.0	1.0	1.0	1.0	1.00	S	28.1	0.28	→(5) Cold Object PVC: If C(meas,BKG)>C(meas,VOI) → C(PVC,VOI)<C(meas,VOI)
VOI 6	1.00								*		→(6) Volume entered without C(meas,VOI) (need both)
VOI 7		100.0							*		→(7) C(meas,VOI) entered without Volume (need both)
VOI 8	0.01	100.0					1.00	S	†		→(8) The magnitude of the correction is too large (refer to cell U24 in the Engine)

* Please check inputs, † A correction of this magnitude is not advised

Figure 13: *This figure explains various ways data can be input, and the impact these inputs have on the resulting correction.*

The corrected activity concentration is calculated using the model-derived RC, which is calculated using each of the inputs in the PVC table. For example, entering background activity C(meas,BKG) will lower the magnitude of the correction as it considers the case where background activity spills into the VOI. For accurate PVC, an estimate of the local background activity is recommended to ensure data is not over-corrected.

It is important to note for all models implemented in MIRDpvc, PVC is applied using a model-derived spill-out recovery coefficient curve. This may be different to approaches some users may have taken before when applying RC-based PVC, where one might just acquire a phantom, fit an RC curve to the measured RCs, and use that curve to apply corrections. What is often not considered when applying PVC is that this approach inherently assumes that all object VOIs have the same object-to-background ratio as that which was present in your phantom experiment. In order to correctly (or as correctly as possible) handle background spill-in, a spill-out RC curve is most appropriate. Likewise, it is highly recommended that users provide local background activity measurements ($C_{meas,BKG}$) when apply PVC (especially for smaller volumes).

The PVC table inputs and outputs (including the applied RC, shape dimensions, etc) can be copied to the clipboard by clicking the icon shown in Figure 14. Additionally, Figure 14 shows that any errors in PVC calculation will be indicated and explained with a corresponding error message.

Copy PVC outputs to clipboard

VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{meas,bkg}$	a	b	c	ψ		$C_{PVC,VOI}$	Corr factor
Tumor 1	6.63	659.5	100.0	10.7	34.7	24.7	0.82	E	1818.1	2.76
Tumor 2	6.39	685.4	140.0	13.5	41.8	15.9	0.85	E	1814.7	2.65
Tumor 3	0.01	451.0		1.0	1.0	1.0	1.00	S	†	
Tumor 4		325.0							*	

* Please check inputs, † A correction of this magnitude is not advised

Error messages

Figure 14: *VOI input messages and PVC outputs. Click the clipboard icon to copy the PVC inputs and outputs to your clipboard.*

RECOVER-GM: The RECOVER-GM model offers shape-specific corrections using a geometric mean of recovery coefficients computed from each axis dimension of an ellipsoid, based on an analytical model of spill-out (explained in more detail below, Eqs. 3 & 4). This enables improved correction for non-spherical volumes and is particularly suited for clinical data where lesion geometry deviates significantly from spherical geometry (where a non-spherical lesion can be approximated by a 3D ellipsoid). An example of the required shape parameters is shown in Figure 15:

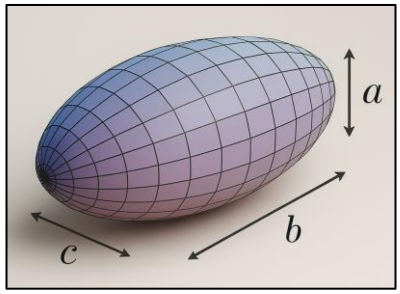


Figure 15: *Diagram showing that the shape-specific input parameters correspond to the 3 axes dimensions of an ellipsoid.*

The following describes the RECOVER-GM model in more mathematical detail, for more information please refer to MIRD pamphlet No. 32). The RECOVER-GM model calculates shape-specific RCs by computing the geometric mean of RCs calculated using the Gustafsson-Mínguez equation [2], which models spill-out RCs for spherical volumes (Eq. 3):

$$\mathrm{RC}_{out,R} = erf\left(\frac{R\sqrt{2}}{\sigma}\right) - \frac{1}{\sqrt{2\pi}}\frac{\sigma}{R}\left(3 - e^{-\frac{2R^2}{\sigma^2}}\right) + \frac{1}{\sqrt{2\pi}}\left(\frac{\sigma}{R}\right)^3\left(1 - e^{-\frac{2R^2}{\sigma^2}}\right), \tag{3}$$

where $\mathrm{RC}_{\mathrm{out,R}}$ is the mean spill-out recovery coefficient for a sphere with radius R, and σ is the standard deviation of a Gaussian function (proportional to the FWHM of the spatial resolution, where $\mathrm{FWHM} = \sigma\sqrt{8ln2}$). The resolution applied in the RECOVER-GM correction is determined by the dimensions of the input object and its generalized radius $\rho = \psi R$. Here, ψ represents the sphericity, defined as the ratio of the surface area of the ellipsoid to that of a volume-equivalent sphere, and *R* is the radius of the volume-equivalent sphere. The resolution (σ) applied in Eq. 3 is calculated using $FWHM = m \times 2\rho + b$, where *m* and *b* are the slope and intercept from the RERC LoBF shown in Figure 8. For an ellipsoid with dimensions (*a,b,c*), the shape-specific RC is calculated as the geometric mean of RCs for spheres with radii equal to each axis dimension:

$$RC_{out,abc} \approx (\mathrm{RC}_a \times \mathrm{RC}_b \times \mathrm{RC}_c)^{\frac{1}{3}}, \tag{4}$$

where RC_a, RC_b, & RC_c are the mean spill-out recovery coefficients for spheres with radii *a*, *b*, & *c*, and each are calculated using Eq. 3. For objects with a generalized radius larger than the resolution applied by the resolution model, RC_{abc} is calculated as $\mathrm{RC}_{\mathrm{out},\rho}$—that is, with the generalized radius used as input into Eq. 3. The resulting shape-specific RC ($\mathrm{RC}_{out,abc}$) is then used to perform PVC. ***Please refer to MIRD No. 32 for more details*** *[1]*.

References

[1] Marquis H, Schmidtlein CR, de Nijs R, et al. MIRD Pamphlet No. 32: A MIRD Recovery Coefficient Model for Resolution Characterization and Shape-Specific Partial-Volume Correction. *Journal of Nuclear Medicine.* 2025:jnumed.124.268520.

[2] Mínguez Gabiña P, Monserrat Fuertes T, Jauregui I, del Amo C, Rodeño Ortiz de Zarate E, Gustafsson J. Activity recovery for differently shaped objects in quantitative SPECT. *Physics in Medicine & Biology.* 2023;68:125012.

Example Exercise

A NEMA IEC phantom experiment was acquired with Lu177 and a sphere-to-background ratio of 8:1 ("***Hot spheres, warm BKG***" experimental set-up with ***SBR = 8***). The data was reconstructed without resolution modelling and with a post reconstruction Gaussian filter of 10 mm FWHM. Recovery coefficients were calculated as C(measured)/C(true), where C(measured) is the concentration measured within the physical boundary of the sphere on the SPECT reconstructed image; C(true) is the known true activity concentration in the sphere. The measured RCs were calculated to be:

Table 1. Sphere diameters and RCs.

Sphere Ø (mm)	Volume (cm^3)	RC(meas)
10.0	0.52	0.19
13.0	1.15	0.26
17.0	2.57	0.35
22.0	5.58	0.43
28.0	11.49	0.53
37.0	26.52	0.66

Lu177 patient data was reconstructed using the same reconstruction protocol (no RM, with post filtering). Eight tumor volumes were segmented (physical volumes defined via anatomical imaging) and the volumes (cc), target concentration (**$C_{meas,VOI}$**, kBq/ml) and local background concentration (**$C_{meas,BKG}$**, kBq/ml) were measured for each target. Additionally, PyRadiomics was used to extract shape dimensions (a,b,c) from the tumor VOIs. The data for all 8 tumor VOIs is shown below in Table 2.

Table 2. VOI metrics.

VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{meas,bkg}$	a	b	c
Tumor 1	6.63	659.5	100.0	10.7	34.7	24.7
Tumor 2	6.39	685.4	140.0	13.5	41.8	15.9
Tumor 3	5.77	581.0	90.0	12.7	53.6	14.7
Tumor 4	5.70	577.5	10.0	10.6	32.2	27.2
Tumor 5	1.84	567.3	300.0	9.4	31.8	11.1
Tumor 6	0.86	376.1	200.0	6.7	21.2	8.4
Tumor 7	0.81	225.4	10.0	6.5	15.2	10.0
Tumor 8	0.48	194.2	80.0	4.1	22.8	9.0

Please perform partial volume correction using 4 different approaches in MIRDpvc. 1) RECOVER-GM with shape-parameters input, 2) spherical assumption (RECOVER-GM) without shape-specific parameters (a=b=c=1, or blank), 3) 3-parameter logistic function, and 4) EANM 2-parameter logistic function. For methods 3) & 4) you will need to obtain RC-curve parameters using the "Fit RC-Curve" tab in the MIRDpvc worksheet. Please follow the instructions outlined there – once the equation parameters have been obtained, copy the values into the MAIN sheet input cells. Please fill out the table with the model calculated **$C_{PVC,VOI}$** values to complete the exercise:

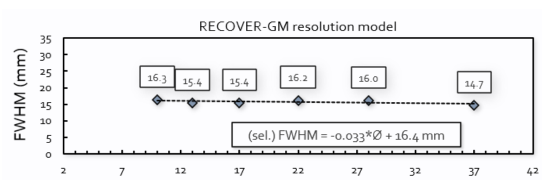
			RECOVER-GM	RECOVER-GM (spherical)	3-PL	EANM 2-PL
VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$
Tumor 1	6.63	659.5				
Tumor 2	6.39	685.4				
Tumor 3	5.77	581.0				
Tumor 4	5.70	577.5				
Tumor 5	1.84	567.3				
Tumor 6	0.86	376.1				
Tumor 7	0.81	225.4				
Tumor 8	0.48	194.2				

Approximate answers to this exercise are below. Try to see if you can get similar numbers.

Completed table:

			RECOVER-GM	RECOVER-GM (spherical)	3-PL	EANM 2-PL
VOI name	V (cm^3)	$C_{meas,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$	$C_{PVC,VOI}$
Tumor 1	6.63	659.5	1825.7	1525.9	1562.2	1585.6
Tumor 2	6.39	685.4	1821.6	1551.1	1587.6	1611.1
Tumor 3	5.77	581.0	1860.9	1417.4	1452.7	1475.6
Tumor 4	5.70	577.5	1876.6	1551.7	1592.8	1619.4
Tumor 5	1.84	567.3	1989.4	1644.2	1639.0	1638.1
Tumor 6	0.86	376.1	2006.0	1725.0	1623.6	1571.3
Tumor 7	0.81	225.4	2112.5	1958.4	1817.7	1745.5
Tumor 8	0.48	194.2	2112.0	1649.8	1446.5	1346.9

RECOVER-GM:



3-PL:

$$\mathrm{RC}_{out} = 1 - \frac{1}{\left[1 + \left(\frac{Vol}{a_1}\right)^{a_2}\right]^{a_3}}$$

3-PL (RC curve)	
a_1	5.184
a_2	0.787
a_3	0.607

2-PL:

$$\mathrm{RC}_{out} = 1 - \frac{1}{1 + \left(\frac{Vol}{b_1}\right)^{b_2}}$$

EANM 2-PL (RC curve)	
b_1	13.739
b_2	0.691