User Manual
Hyperpolarized ^{129}Xenon MRI Analysis App

For Research Use Only

User's Manual

HP ^{129}Xe MRI Analysis App

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1 | Overview

Main Menus:

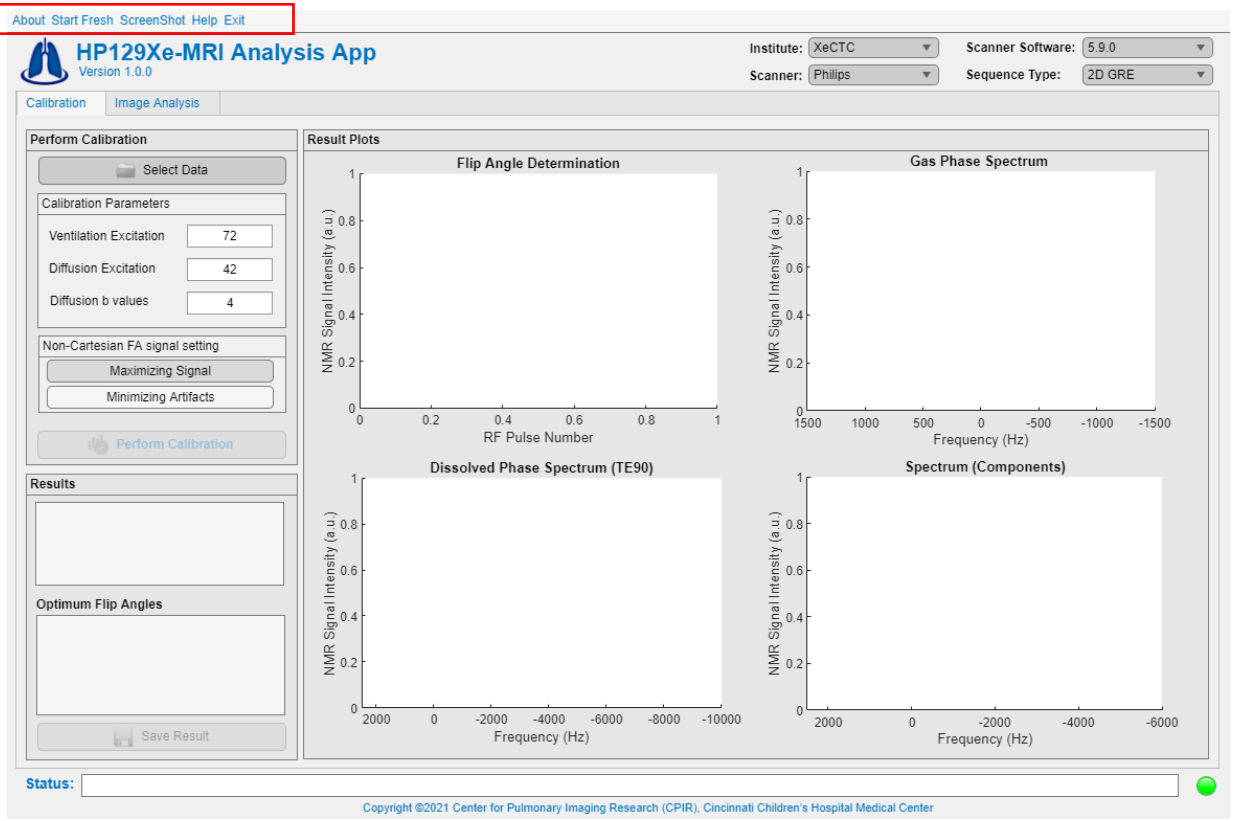
About: Provides an insightful overview of the application and its functionalities.

Start Fresh: Restores the app to its default settings and eliminates all variables. This feature proves beneficial when handling numerous subjects consecutively.

Screenshot: Captures the entire app window and saves it as a high-quality PNG file.

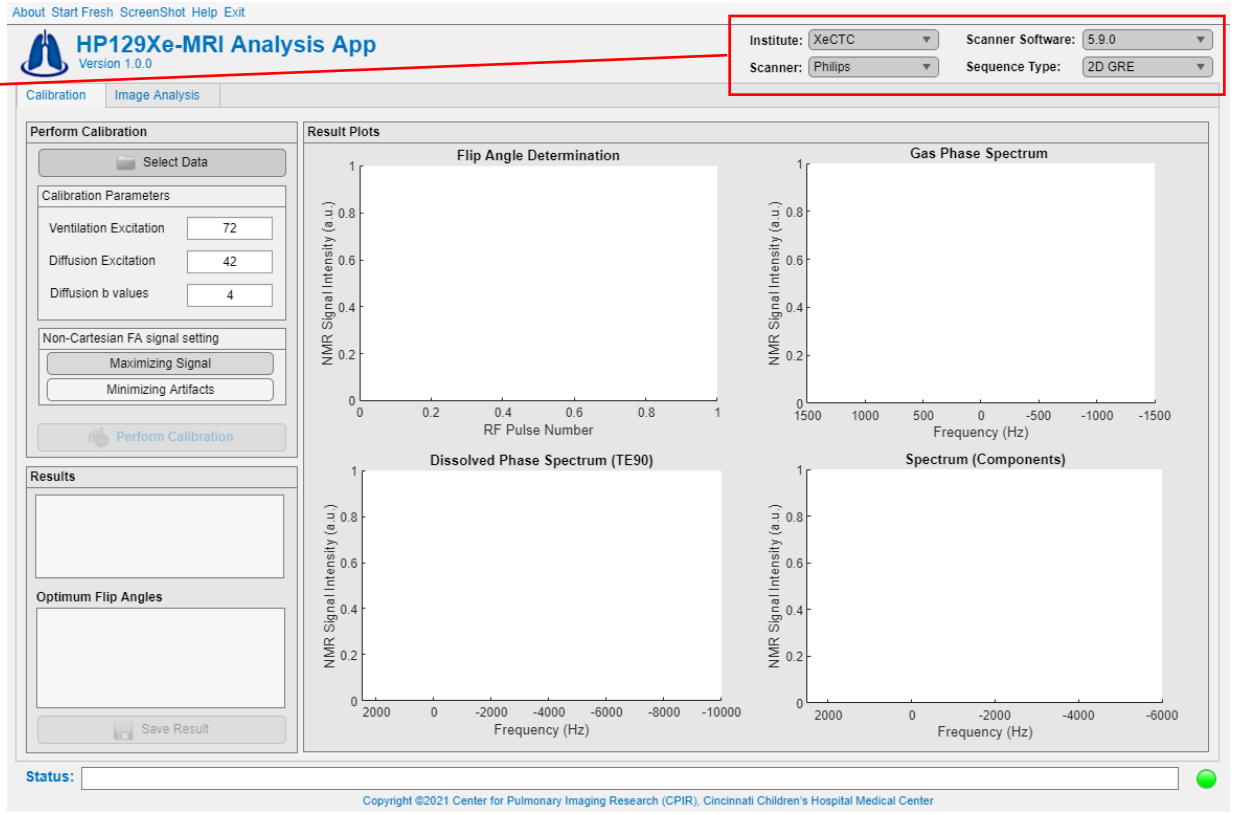
Help: Guides you to the comprehensive user manual, offering assistance and clarification.

Exit: Safely shuts down the application, concluding the user's session.



Institutes and Scanner Options:

These exceptional features allow for seamless customization of the application according to your specific requirements. They prove particularly valuable when working with multiple scanners, scanner software versions, and sequences.

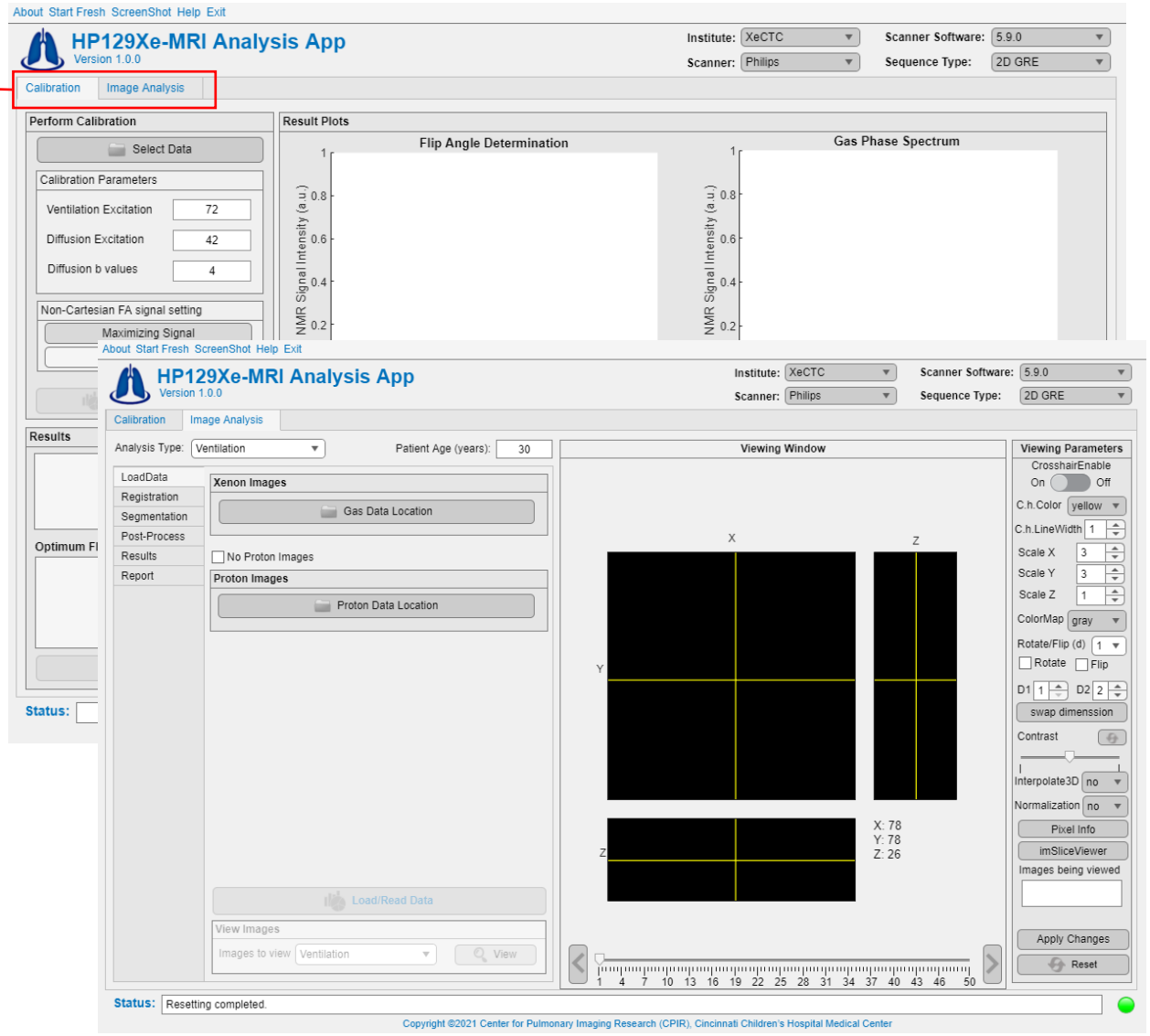


Main Tabs:

Calibrations: Manages flip angles and frequency calibration, ensuring precise adjustments for optimal acquisitions.

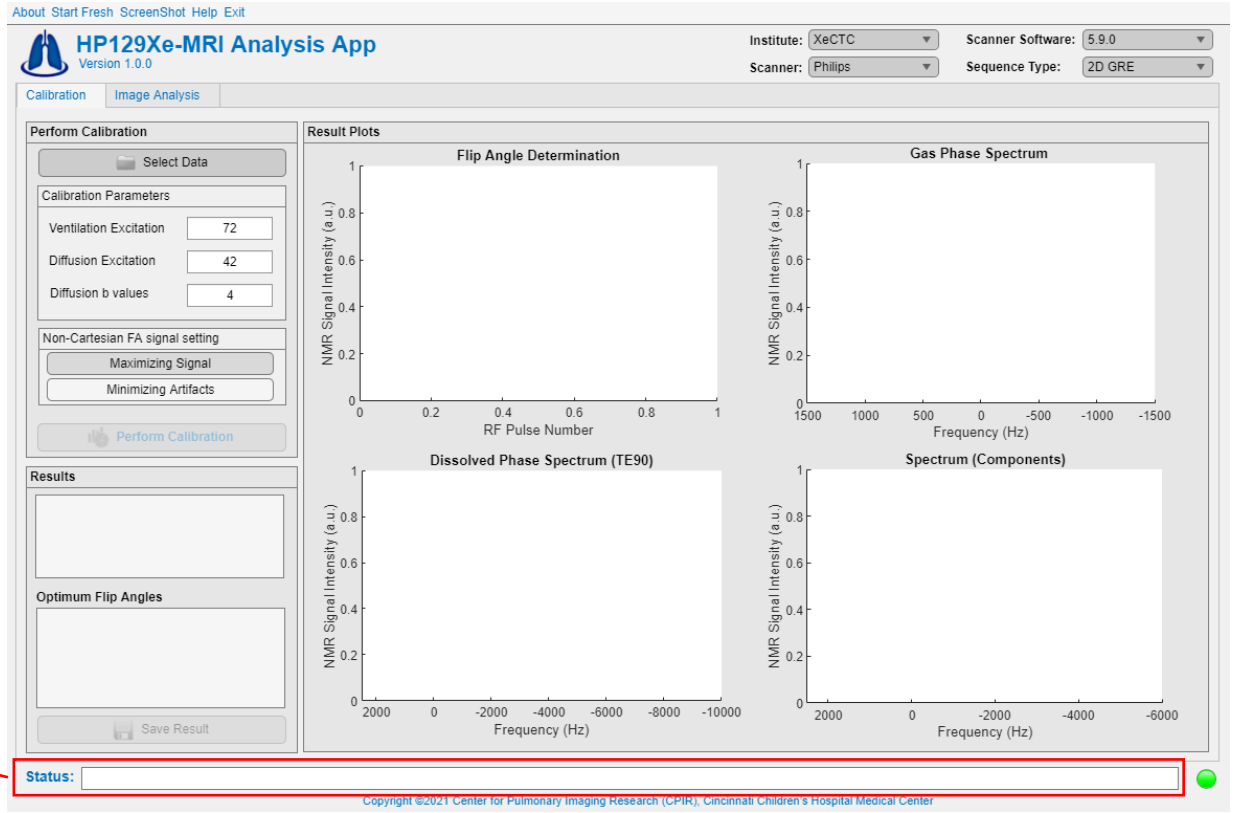
Image Analysis: Facilitates image reconstruction and conducts comprehensive post-processing analysis, enabling in-depth examination and evaluation.

Note: These two tabs operate independently from each other, maintaining separate sets of parameters. There is no parameter sharing between them, ensuring complete autonomy and flexibility.



Status Window:

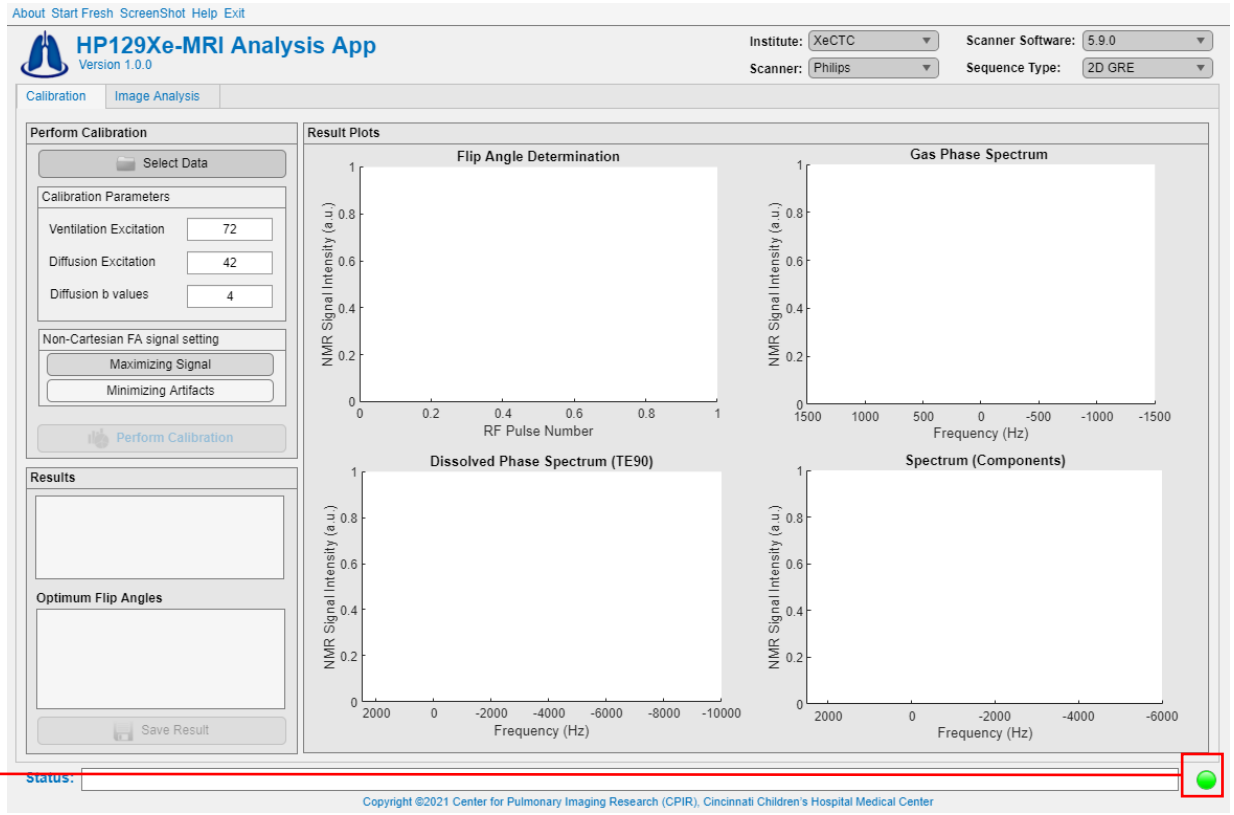
The status window presents a text box that provides real-time updates on tasks and displays error messages when necessary. It serves as a valuable tool for tracking progress and promptly addressing any issues that may arise.



Lamp:

Green: Signals that the app is ready for execution, indicating availability for use.

Red: Indicates that the app is currently unable to process tasks. It's important to note that if a bug occurs and the process halts midway, the lamp will not turn green until another task is initiated.



2 | Flip Angle and Frequency Calibration

2.1 | Input

Perform Calibration Analysis:

1- Select Data: Choose the flip angle calibration data from the available options (refer to Table 2.1 for supported data types).

2 – Perform Calibration: Read in the selected data and conduct essential fittings and calculations to obtain accurate results. The determined optimal flip angles and frequency parameters are subsequently entered prior to image acquisition.

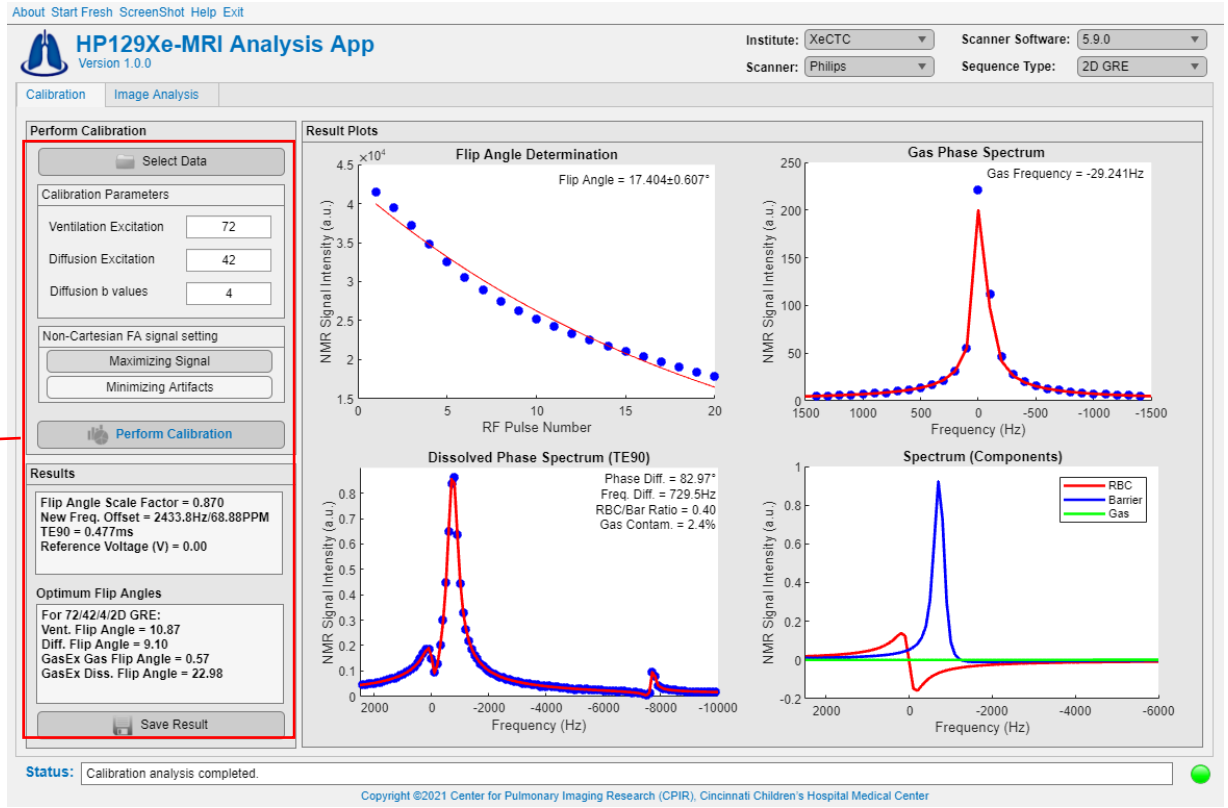


Table 2.1: Supported data type for Calibration analysis

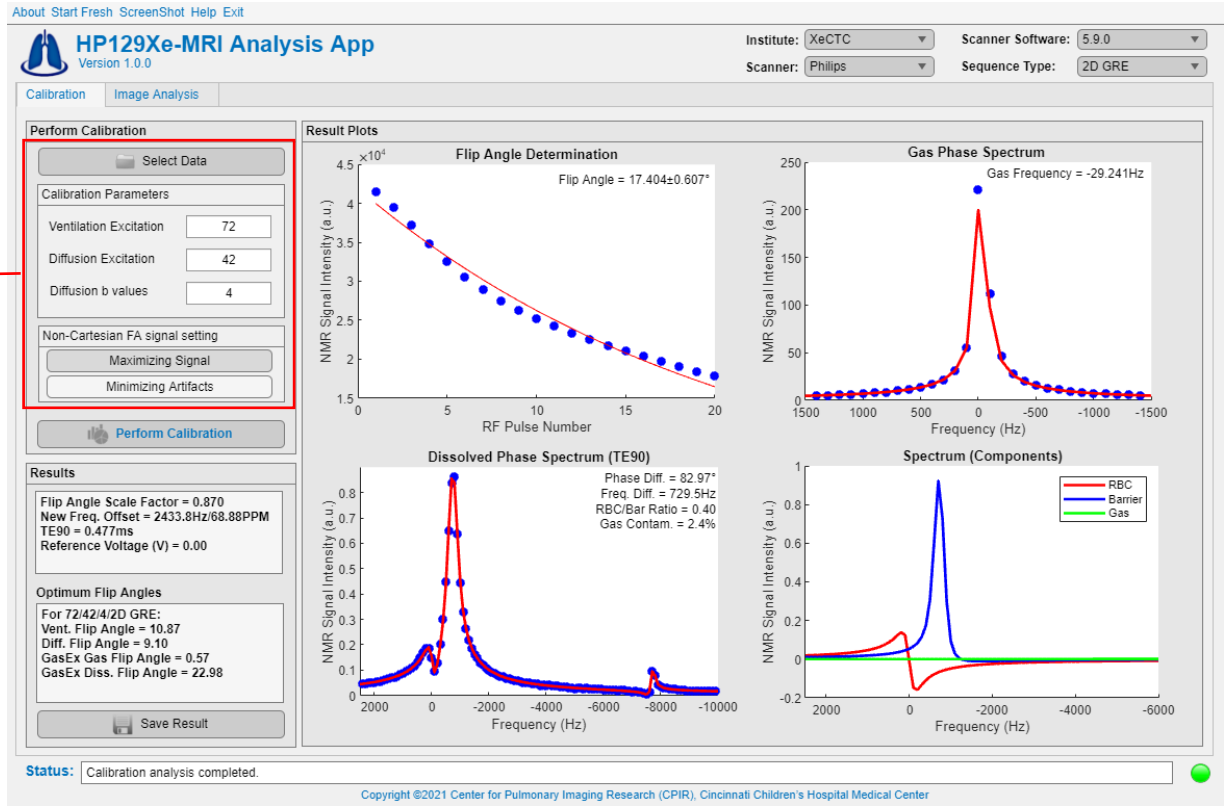
Scanner	Philips	Siemens	GE
Data Type	.data*/.list	.dat*	

* The data that needs to be selected!

2.2 | Adjusting Parameters

Perform Calibration Analysis:

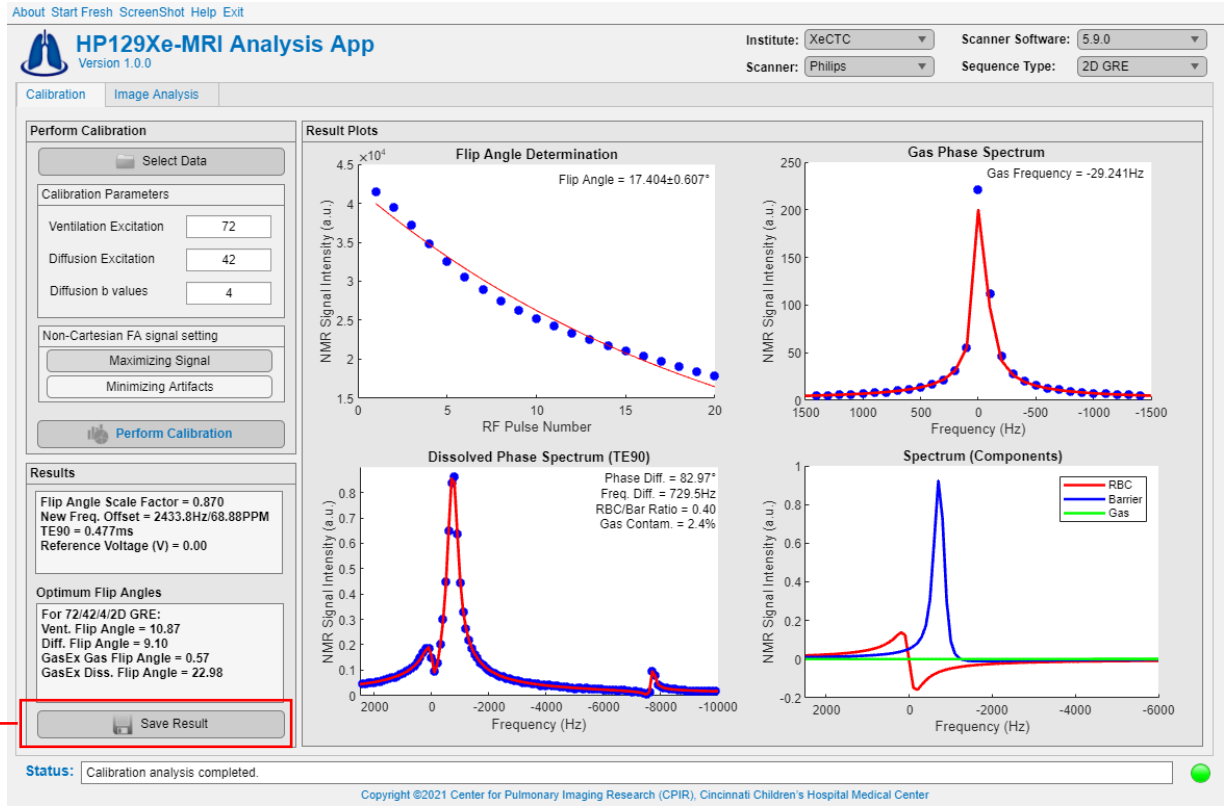
The calibration analysis allows for flexibility in adjusting parameters both before and after the analysis. These input parameters possess a dynamic property, meaning that any changes made to their values will automatically update the calculations. This enables effortless refinement and adaptation of the analysis based on parameter modifications.



2.3 | Save Results

Save Results:

Saves a screenshot of the entire app window as a PNG and PDF files in the data path.



3 | Image Analysis

3.1 | Inputs

Load Data:

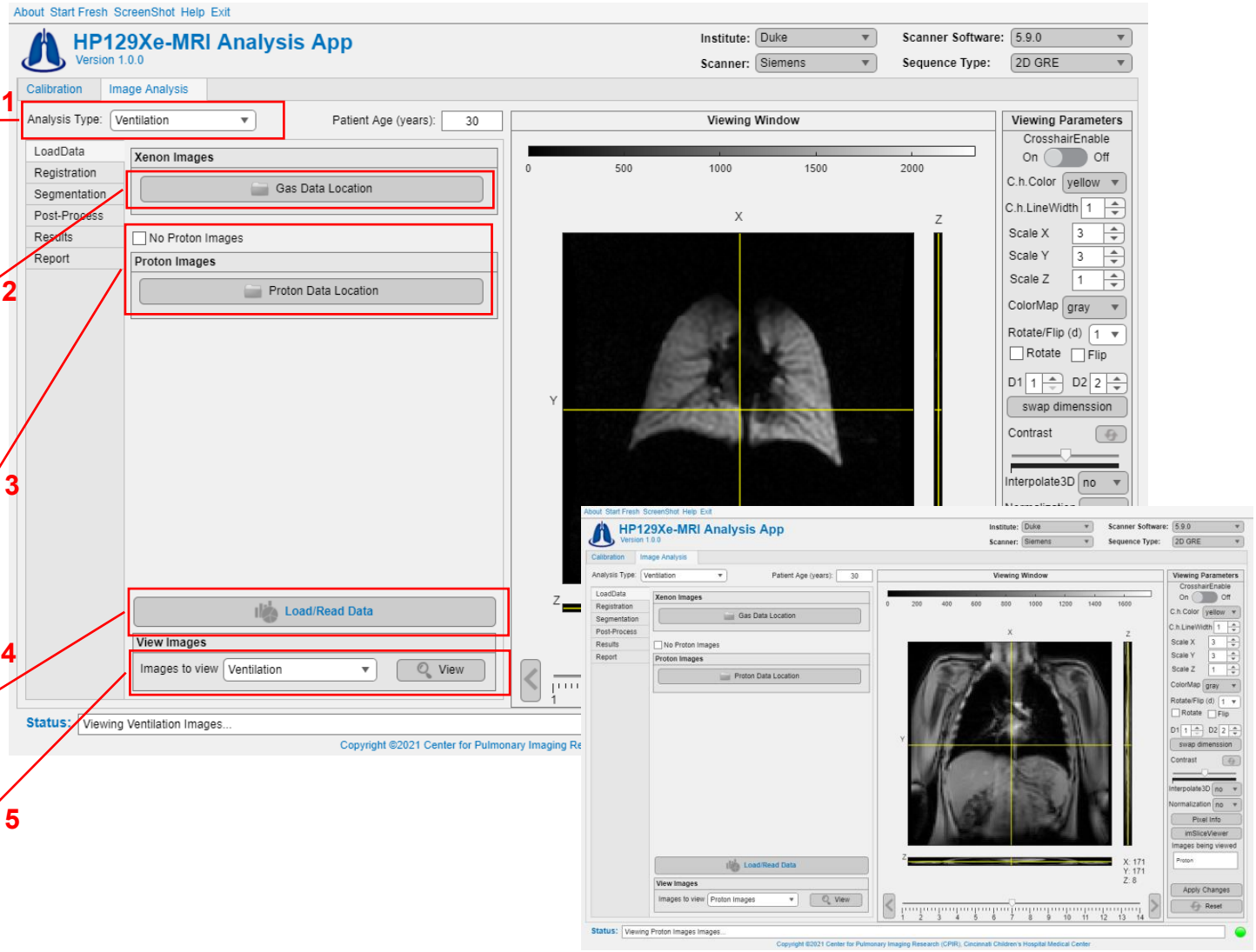
1- Choose Analysis Type: Select the desired type of analysis from the available options.

2- Gas Data Selection: Choose the data file/s for analysis. If raw data is selected, reconstruction functions will be invoked to process the data.

3- Proton Data Selection: If proton data is available, select the corresponding data. Otherwise, check the "No Proton Images" box.

4- Load Data: Load the selected data for further processing and analysis.

5- Image Selection: Select the specific type of images to view.



3.2 | Registration

Perform Registration:

1. Registration Type Selection: Choose the desired registration type, with "affine" being the recommended option for optimal results.

2. Image Resolution: If the two images have different voxel sizes, it is advisable to specify the image resolution for accurate registration. The ratio of the image sizes can also be used as a reference.

3. Slice Selection: In case the slices of the images do not align, you can specify the starting and ending slices of the matched region. Linear interpolation will be employed to adjust the number of slices accordingly.

4. Registration Process: Initiate the registration process for multimodal 3D medical images.

5. Image Selection: Select image type to view.

3.3 | Segmentation

Manual Registration:

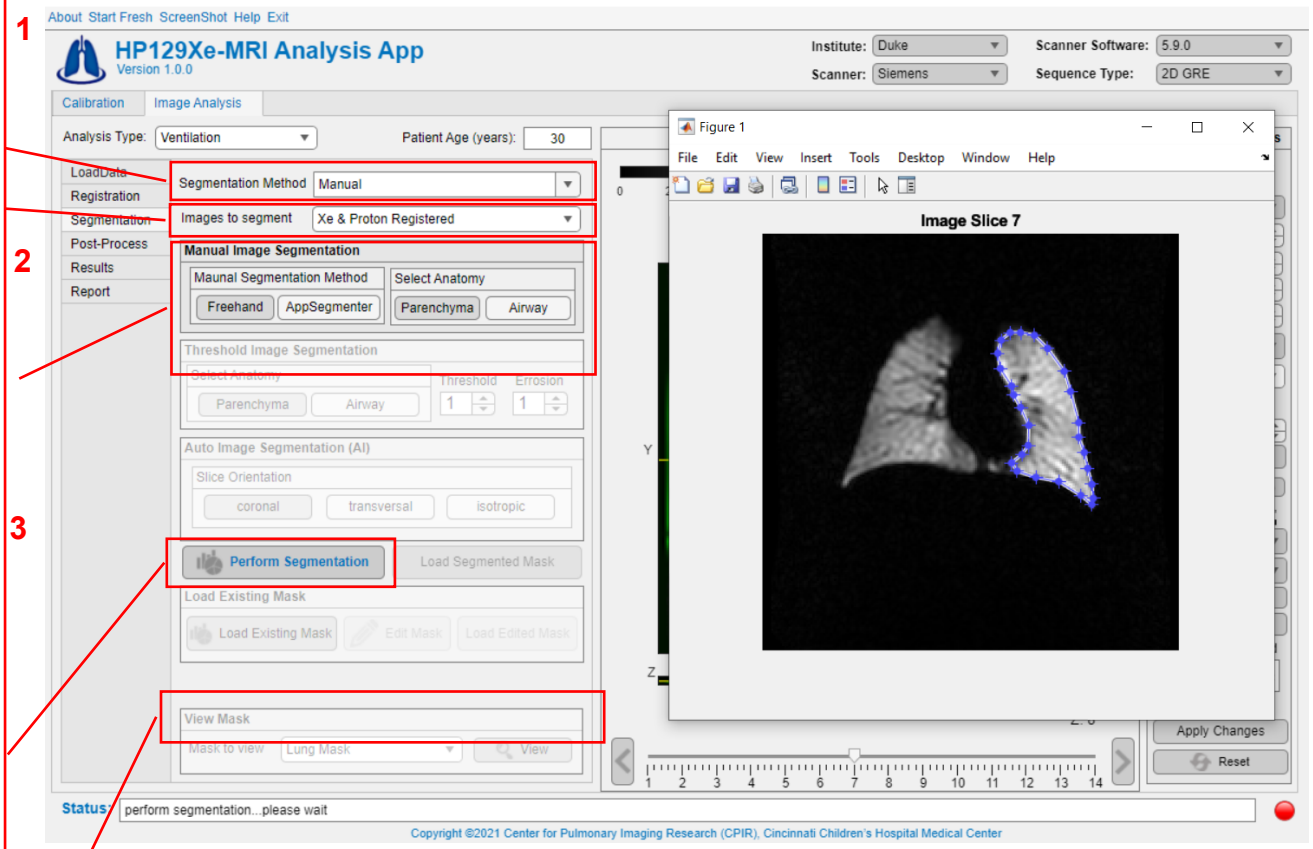
1. Registration Type Selection: Choose the desired registration type, with "affine" being the recommended option for optimal results.

2. Image Resolution: If the two images have different voxel sizes, it is advisable to specify the image resolution for accurate registration. The ratio of the image sizes can also be used as a reference.

3. Slice Selection: In case the slices of the images do not align, you can specify the starting and ending slices of the matched region. Linear interpolation will be employed to adjust the number of slices accordingly.

4. Registration Process: Initiate the registration process for multimodal 3D medical images.

5. Image Selection: Select image type to view.



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3.4 | Results

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3.6 | Viewing Window

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1. Walkup LL, Woods JC. Translational applications of hyperpolarized 3He and 129Xe. NMR in Biomedicine 2014;27(12):1429-1438.
2. Goodson BM. Nuclear magnetic resonance of laser-polarized noble gases in molecules, materials, and organisms. Journal of Magnetic Resonance Imaging: An Official Journal of the International Society for Magnetic Resonance in Medicine 2002;155(2):157-216.
3. Ruppert K. Biomedical imaging with hyperpolarized noble gases. Reports on Progress in Physics 2014;77(11):116701.
4. Mugler III JP, Altes TA. Hyperpolarized 129Xe MRI of the human lung. Journal of Magnetic Resonance Imaging 2013;37(2):313-331.
5. Bdaiwi AS, Niedbalski PJ, Hossain MM, Willmering MM, Walkup LL, Wang H, Thomen RP, Ruppert K, Woods JC, Cleveland ZI. Improving hyperpolarized (129) Xe ADC mapping in pediatric and adult lungs with uncertainty propagation. NMR Biomed 2021:e4639.
6. Loew W, Thomen R, Pratt R, Cleveland Z, Dumoulin C, Woods J, Giaquinto RO. A dual loop T/R -Xenon coil for homogenous excitation with improved comfort and size ISMRM2016.

7. Niedbalski PJ, Bier EA, Wang Z, Willmering MM, Driehuys B, Cleveland ZI. Mapping cardiopulmonary dynamics within the microvasculature of the lungs using dissolved 129Xe MRI. 2020;129(2):218-229.
8. Willmering MM, Niedbalski PJ, Wang H, Walkup LL, Robison RK, Pipe JG, Cleveland ZI, Woods JC. Improved pulmonary 129Xe ventilation imaging via 3D-spiral UTE MRI. Magnetic Resonance in Medicine 2020;84(1):312-320.
9. Abdullah S. Bdaiwi, Matthew M. Willmering, Hui Wang, Cleveland ZI. 2D and 3D Spiral for Diffusion Weighted MRI with Hyperpolarized 129Xe. International Society for Magnetic Resonance in Medicine. Virtual2021.
10. Niedbalski PJ, Hall CS, Castro M, Eddy RL, Rayment JH, Svenningsen S, Parraga G, Zanette B, Santyr GE, Thomen RP, Stewart NJ, Collier GJ, Chan H-F, Wild JM, Fain SB, Miller GW, Mata JF, Mugler III JP, Driehuys B, Willmering MM, Cleveland ZI, Woods JC. Protocols for multi-site trials using hyperpolarized 129Xe MRI for imaging of ventilation, alveolar-airspace size, and gas exchange: A position paper from the 129Xe MRI clinical trials consortium. 2021;86(6):2966-2986.