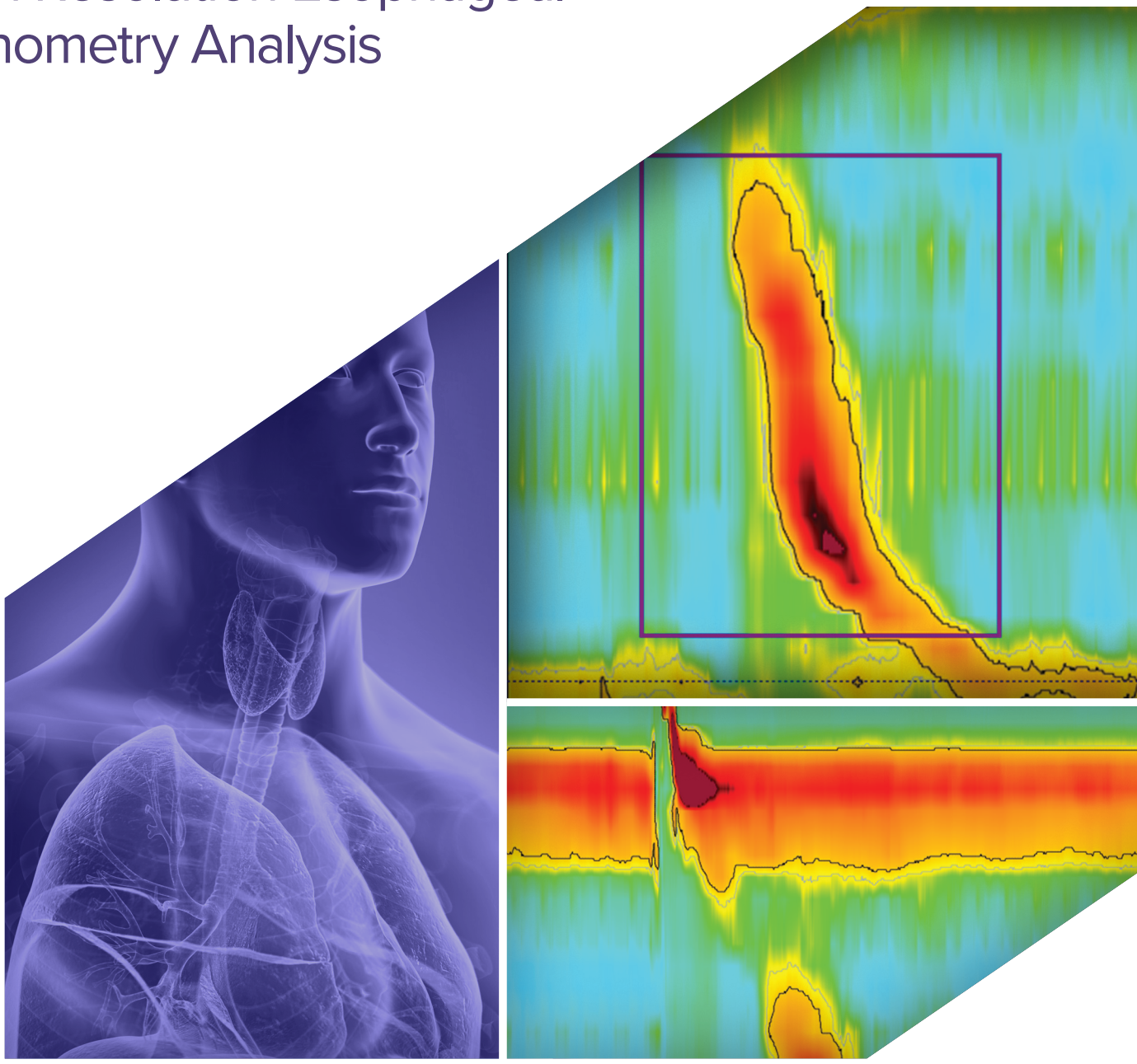
Diversatek Healthcare

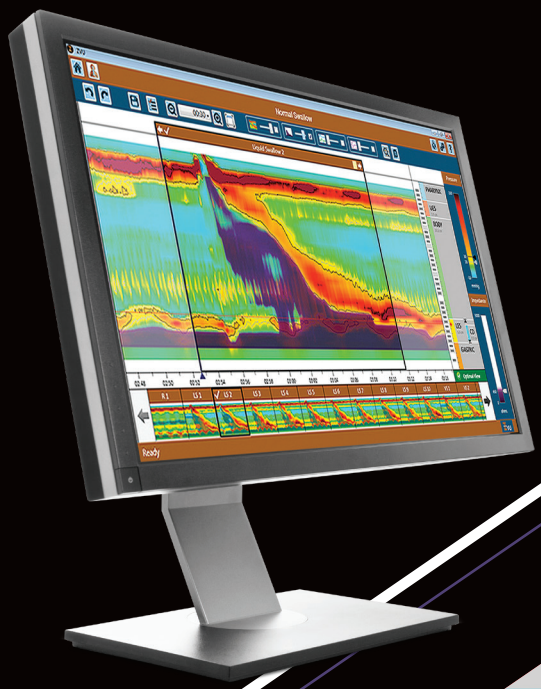
Zvu® Guide

High Resolution Esophageal Manometry Analysis



Zvu®

Diversatek™
Healthcare



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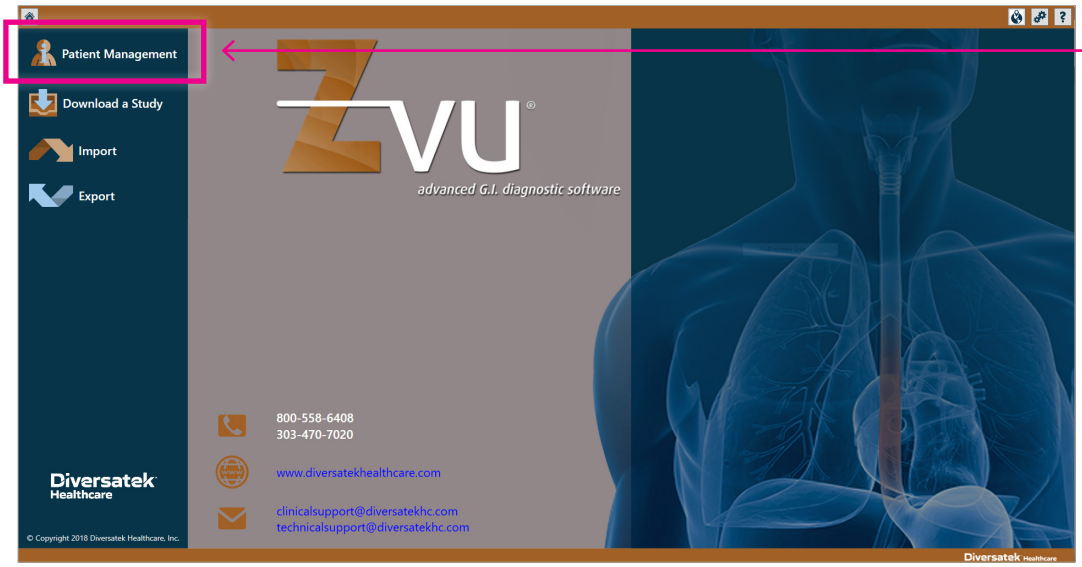
Select a Patient

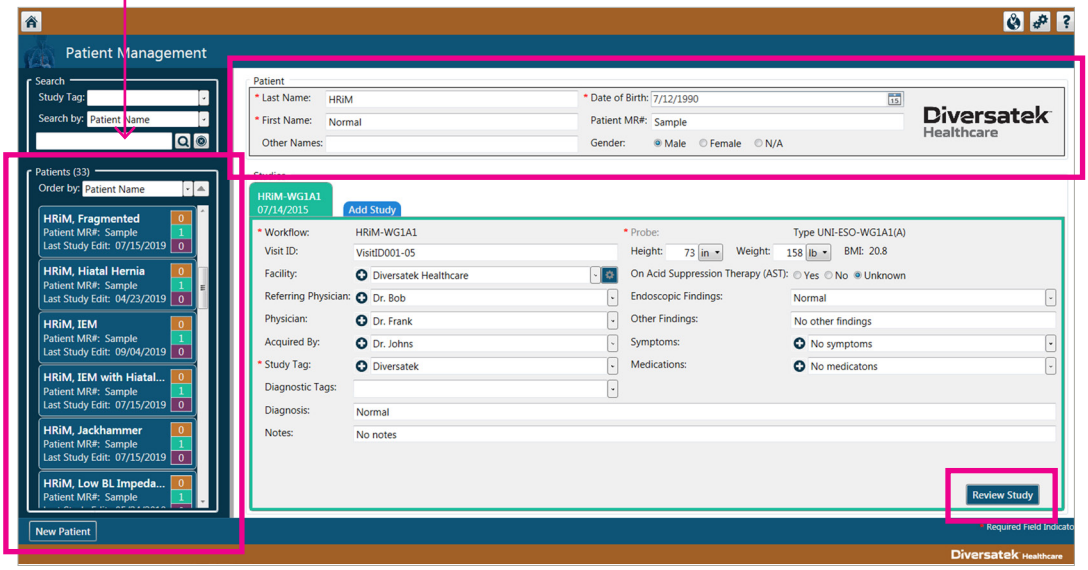
Double click on the Zvu icon to open the Zvu® application.



Patient Management

Click on **Patient Management** on the left side of the screen.

Select the desired patient in the patient list.



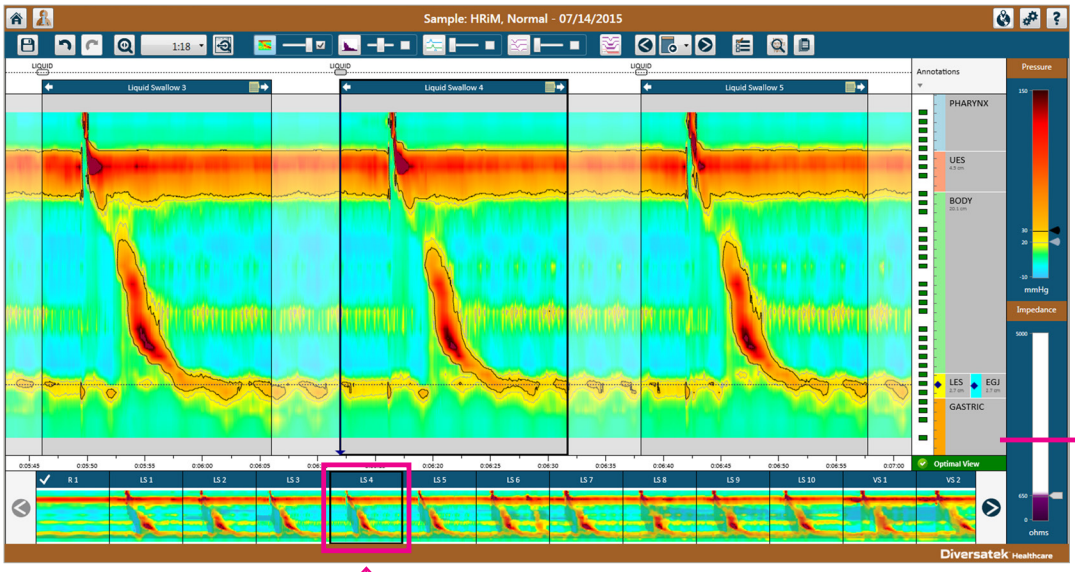
In the **Patient Section,** verify and correct the information if needed.

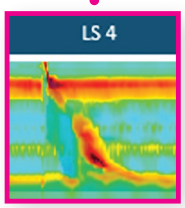
Review Study

Click **Review Study** in the lower right hand corner.

Important Order of Operations

1. View and if necessary, adjust the temperature compensation.
2. In the Resting Measurement, set the probe bar for the UES, LES and EGJ borders and the diamonds at the high pressure zones.
3. If the Resting Measurement is at the end of the study, set the probe bar for the first swallow measurement also.
4. Resize/add/delete measurements and annotations as needed.
5. If any Red Dot notifications appear, resolve per the instructions given.
6. Open metrics.
7. Adjust the Pharyngeal, Body and Gastric Baselines if needed in the Resting measurement. The same can be done for all other resting measurements in the study.
8. Click on the R1 measurement. Click and drag the PIP line down below the diaphragm. Slowly drag it up to the first point of maximum inversion and release to mark PIP.
9. Starting with the first swallow measurement, review each measurement in the study and adjust analysis marks as needed. Move from left to right through the complete study.
10. Complete any desired fields in the Study Summary section of Metrics.
11. Save changes.
12. Generate and review reports.

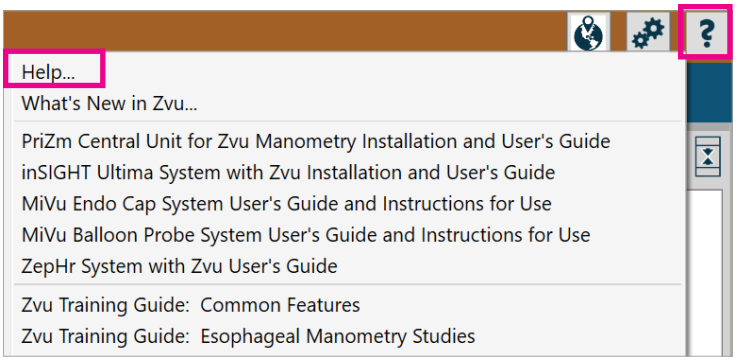




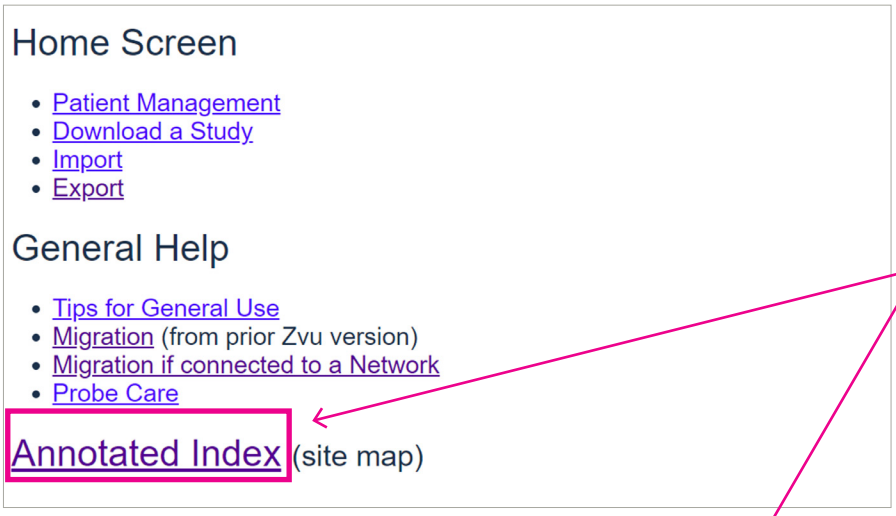
When opened, the full study is shown in one view, and the thumbnail bar shows an image of each measurement

Thumbnail bar

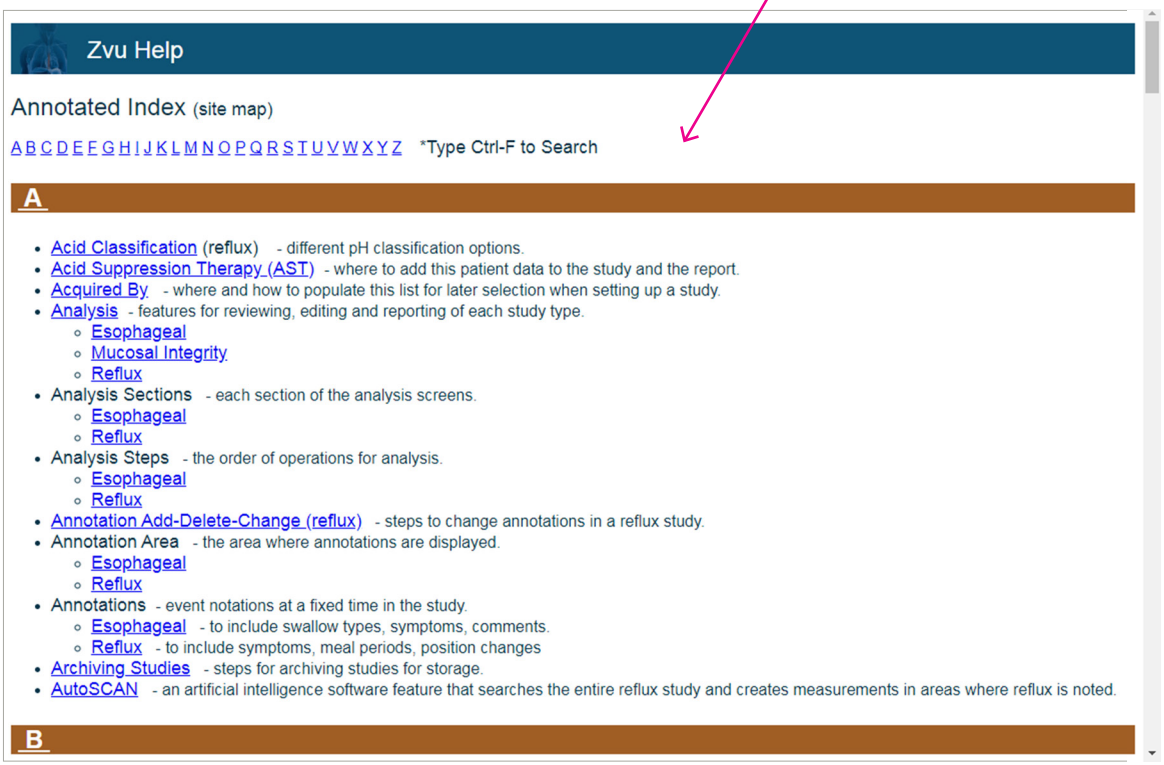
Study Setup



For additional details click the **?** icon on the right end of the toolbar to access **Help**.

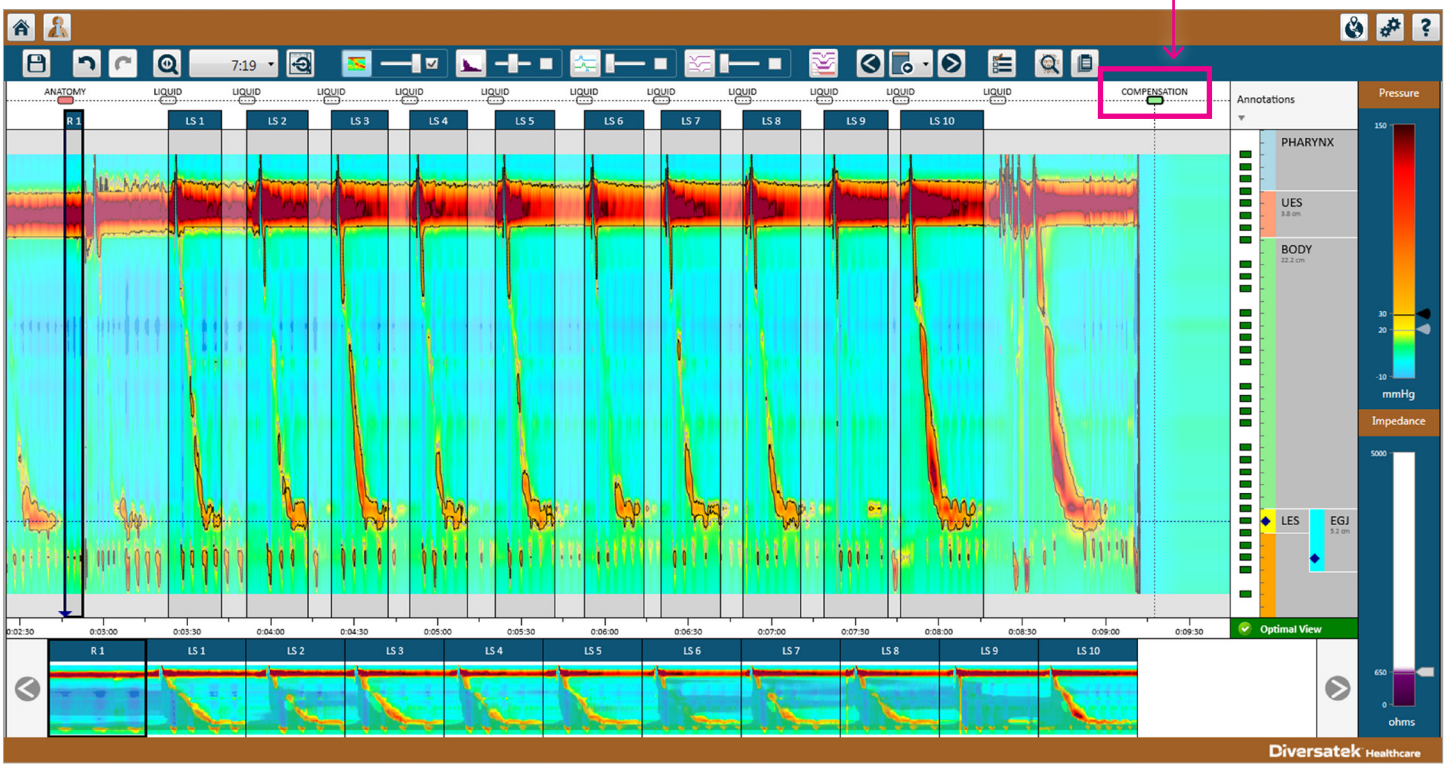


The **Annotated Index** will navigate to the full **Help** list.



Environmental Compensation

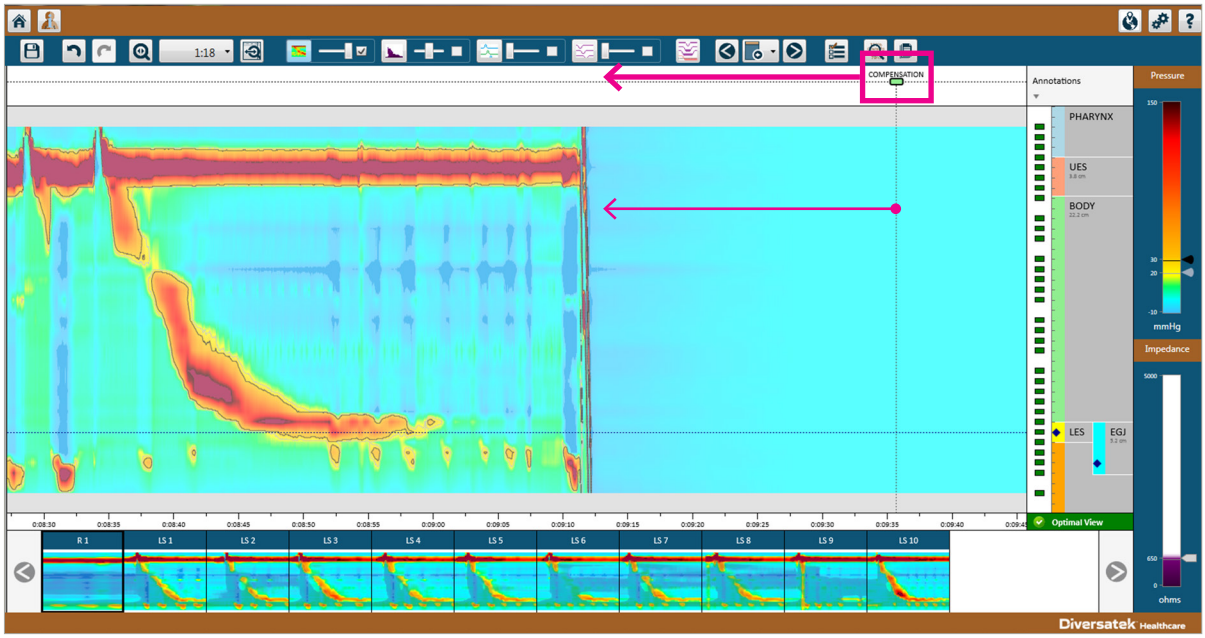
The Environmental Compensation corrects the probe calibration to body temperature.



Review/Adjust the Environmental Compensation.

Double click on the **Compensation** annotation mark (green bubble) located at the end of the study just after the patient was extubated. This will open the time scale to 1 minute at the point of the Environmental Compensation.

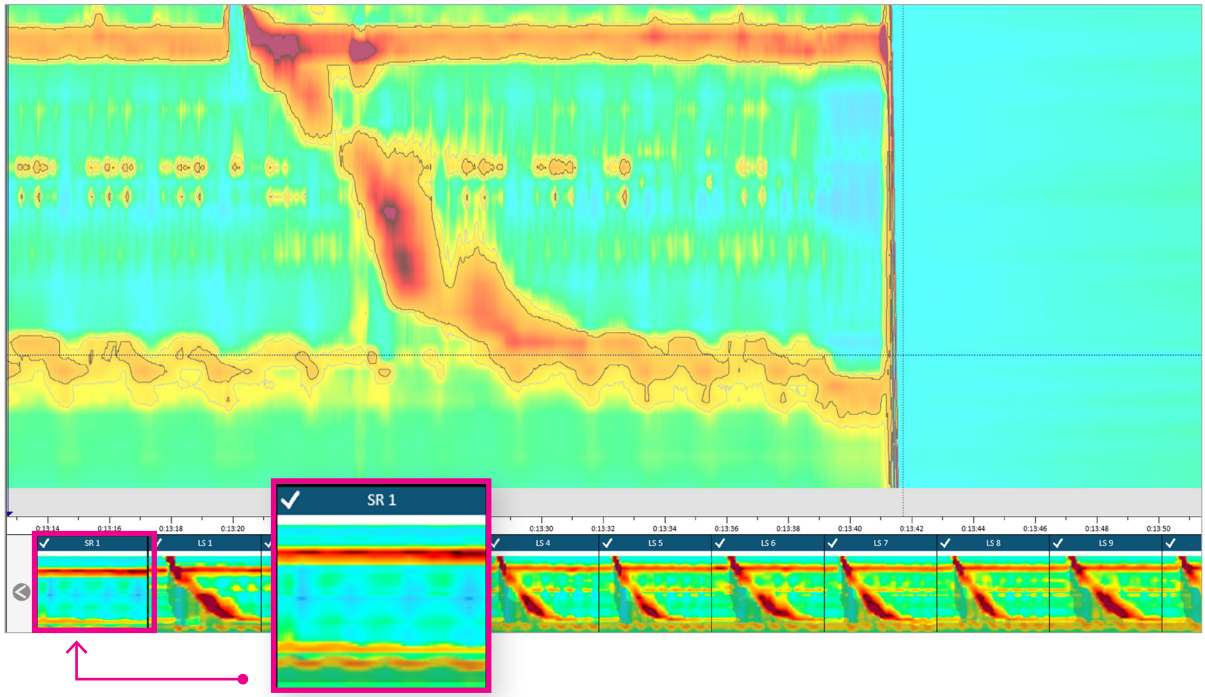
Click and drag the **Compensation** annotation mark to a point just after extubation and away from any area of pressure (indicated by a warm color).



Click the **Save** icon.

Resting Measurement

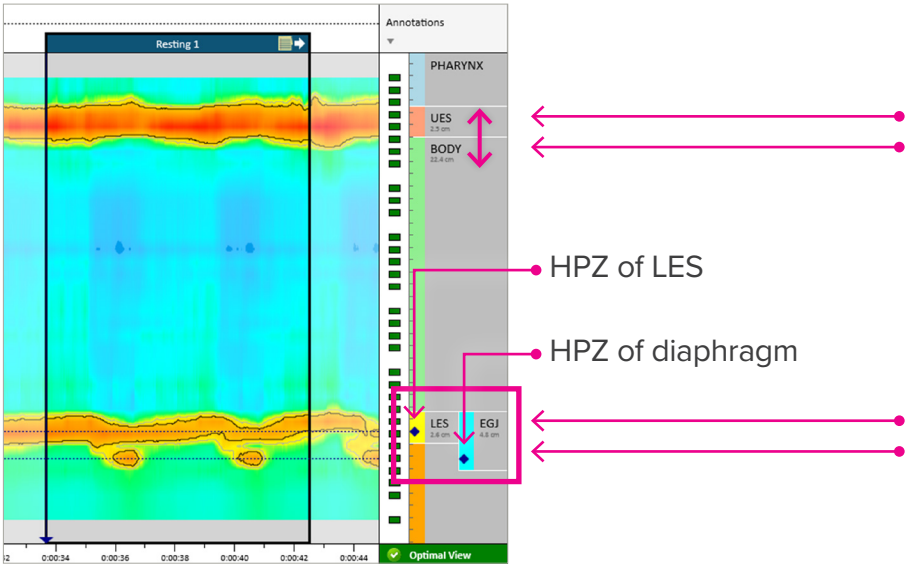
Double click on **SR1** (Supine Resting) in the thumbnail bar to open the resting measurement.



Probe Bar Adjustment

Adjust the **UES** and **LES** borders on the probe bar as needed.

Note: This step is required before opening Metrics.



Hover the cursor over each white border on the probe bar. Click and drag to align with the top and bottom margins of the sphincter. Do this for both the **UES** and **LES.** *If a hiatal hernia is visible, adjust the distal EGJ border to the distal edge of the diaphragm.*

Set the High Pressure Zone (HPZ) of the **LES** marker to the point of highest pressure (warmest color) in the **LES:** Do this by clicking and dragging the blue diamond within the **LES** area on the Probe Bar.

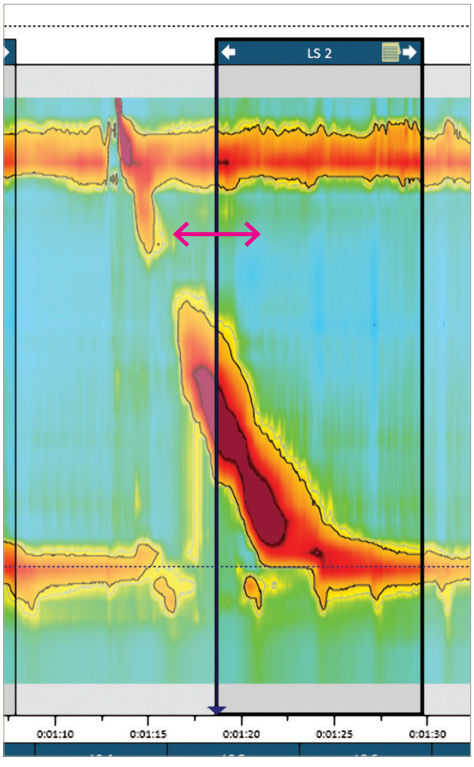
Set the **EGJ** blue diamond with a click and drag to the level of warmest color at the diaphragm HPZ if it is separate from the HPZ of the LES.

If the Supine Resting Measurement is at the end of the study, be sure to also set the probe bar for the first measurement in the study (usually Liquid Swallow 1).

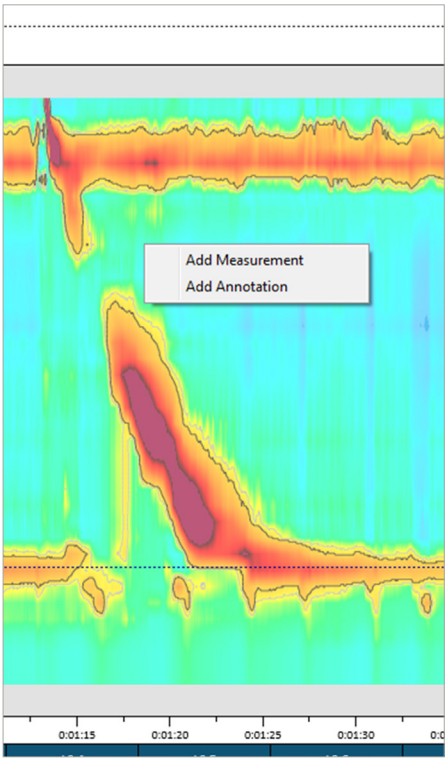
Clean Up Study Prior to Analysis

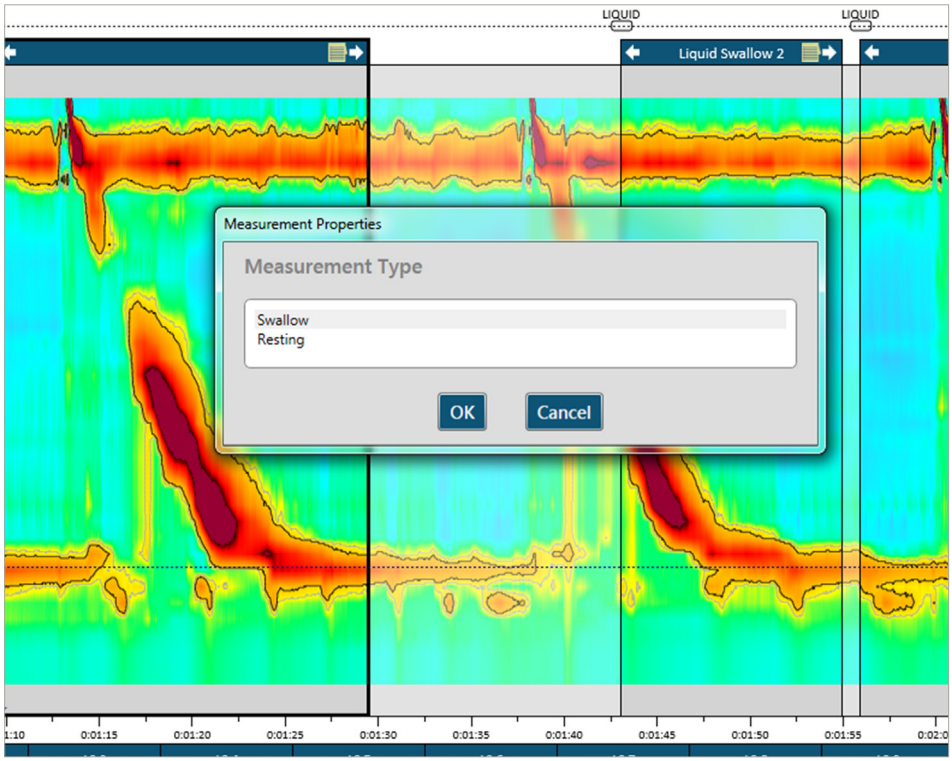
Review the thumbnails for any measurements that may need deleting (double swallows) or adjusting. To navigate to a measurement to be adjusted, click on the corresponding thumbnail.

To resize a measurement, hover the cursor arrow over the border of the measurement window then click and drag to adjust.



Study Setup





To add a measurement or an annotation, right click in the data area outside of a measurement and select the desired option.

After selecting **Add Measurement,** click and drag to the right in the data area to define the size of the measurement. Then select the measurement type.

After selecting **Add Annotation,** click in the data area to define the spot for the annotation. Then select the annotation type.

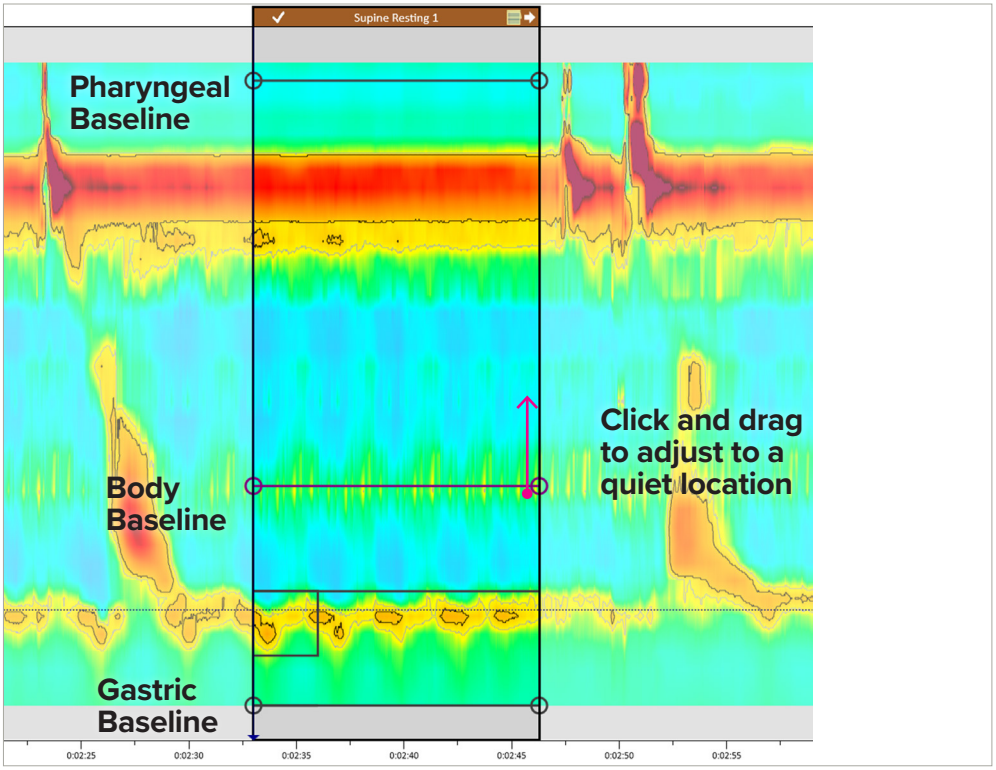
To delete an annotation, right click on the annotation bubble and select **Delete Annotation.**

To delete a measurement, right click on the measurement title bar or anywhere inside the measurement thumbnail and select **Delete Measurement.**

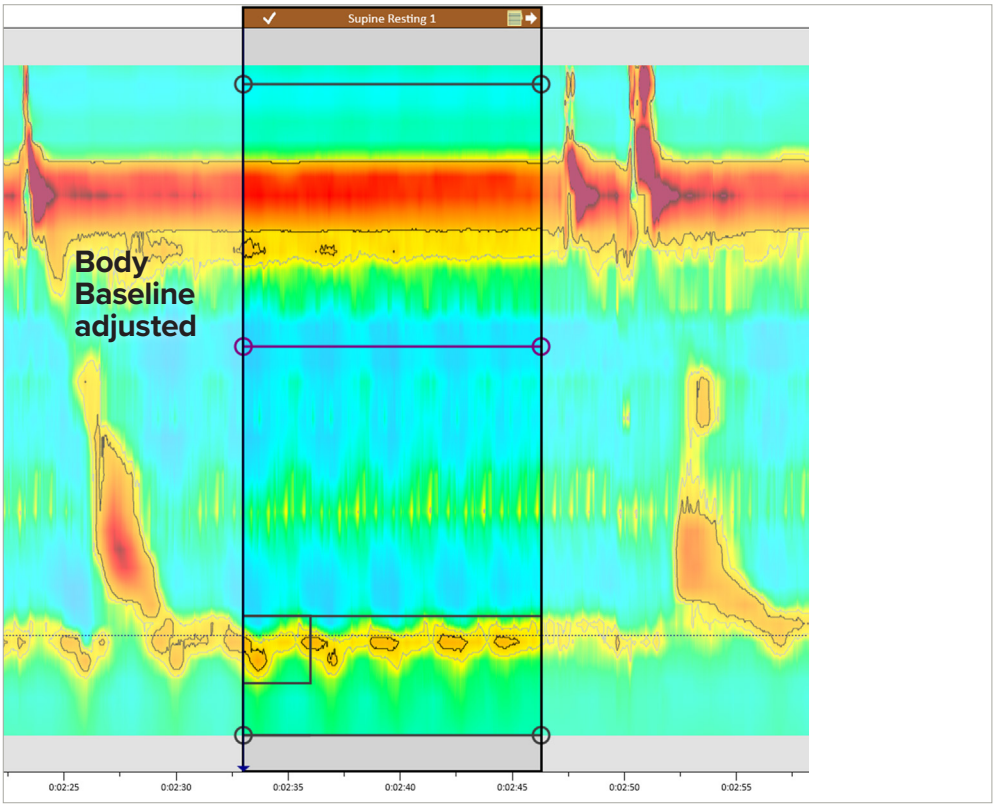
If any Red Dot notifications have appeared, follow the instructions given to resolve any desired red dots prior to opening Metrics.

Turn on Metrics to Show and Adjust Marks

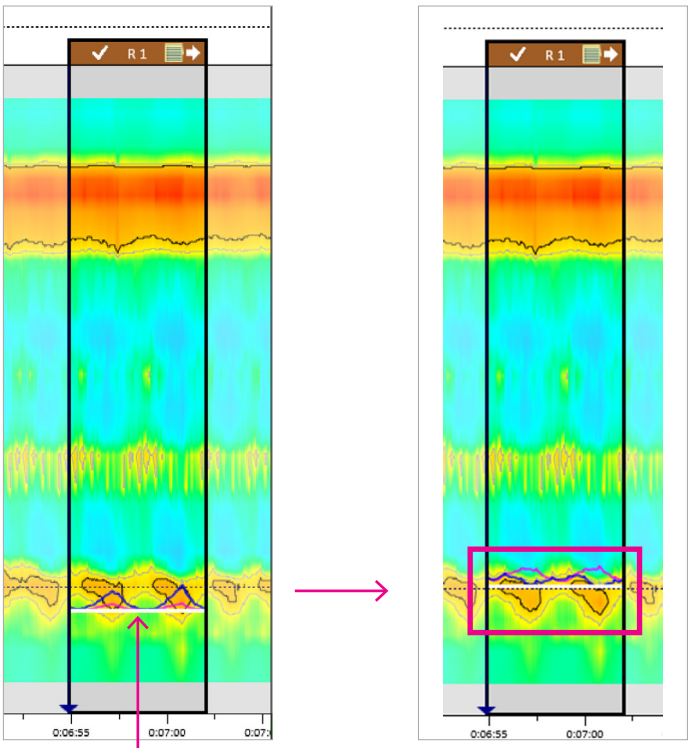
Open Metrics to run the study analysis.



In the **Supine Resting Measurement,** if needed, adjust the **Pharyngeal, Body** and **Gastric Baselines** to a quiet, cool colored area with the lowest available pressure.

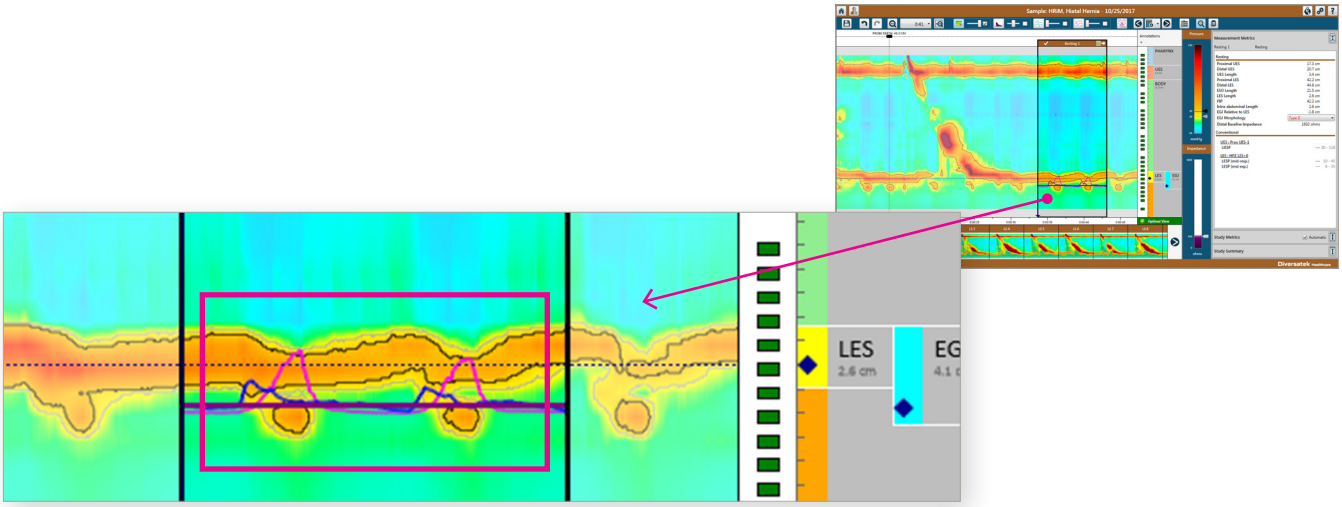


Adjust Pressure Inversion Point (PIP) Reference Bar



Click and drag the **PIP Reference Bar** into the gastric area then slowly move it proximally.

Observe the respiratory cycles of the red and blue waveforms. Drag to the point where the blue waveform is inverted from the red. Release the mouse to set PIP.

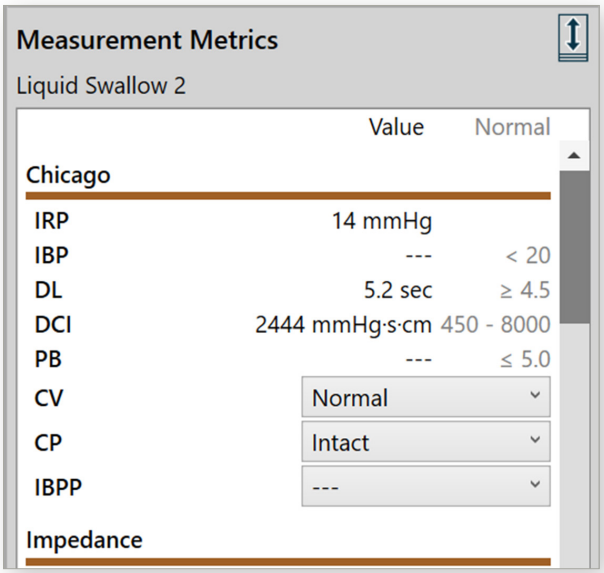


Click the **Save** icon.

Note: If the patient has a hiatal hernia, the PIP should be identified at the point of the diaphragm. Drag up to the first point where the blue waveform is inverted from the red.

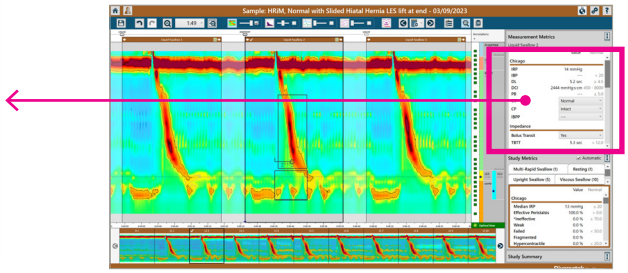
Chicago Analysis

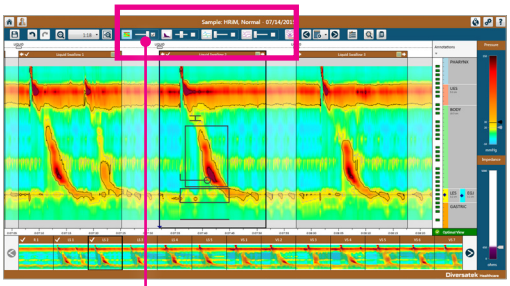
Swallow Measurements



Chicago Calculations

The **Chicago Classification** values are displayed at the top of the **Measurement Metrics.**





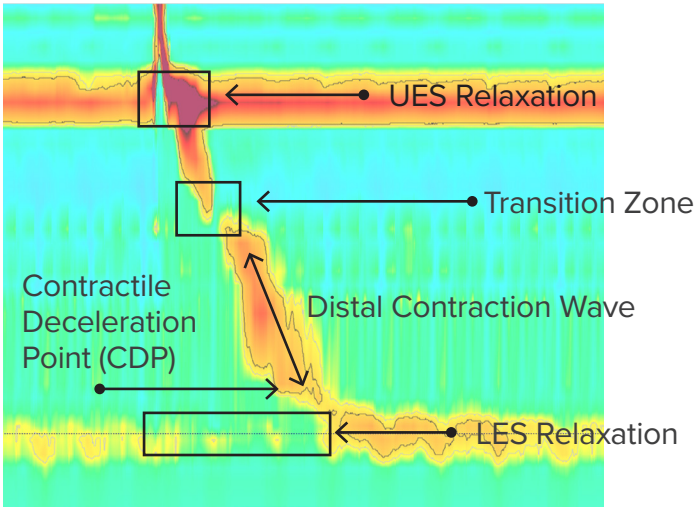
On with check mark | **Off** | **Off** | **Off**

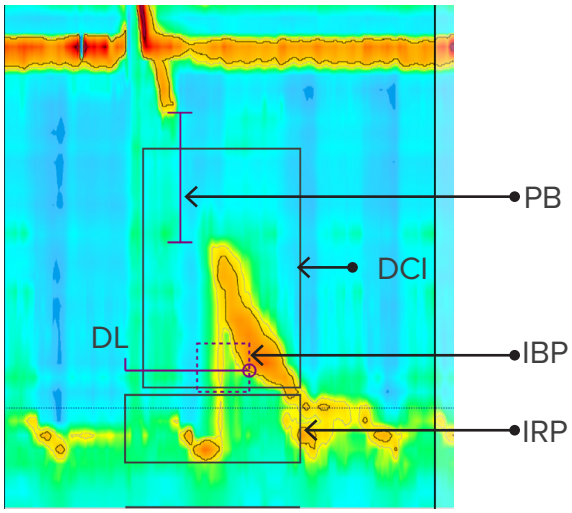
Turn off the Impedance Contour, Pressure and Impedance Waveforms.

Turn on Pressure Contour with the check mark.

Chicago Analysis

Anatomic Features Used in Chicago Classification Analysis of Swallow Measurements





Applying the Metrics

Metric	Abbreviation	Unit of Measure	Definition
Integrated Relaxation Pressure	IRP	mmHg	Mean of the 4s of the maximum deglutitive relaxation in the 10-s window beginning at UES relaxation
Distal Contractile Integral	DCI	mmHg.s.cm	Amplitude x duration x length of the distal esophageal contraction exceeding 20 mmHg from the transition zone to the proximal margin of the LES
Distal Latency	DL	sec	Interval between UES relaxation and the contractile deceleration point (CDP)
Peristaltic Break	PB	cm	Break in the 20 mmHg isocontour

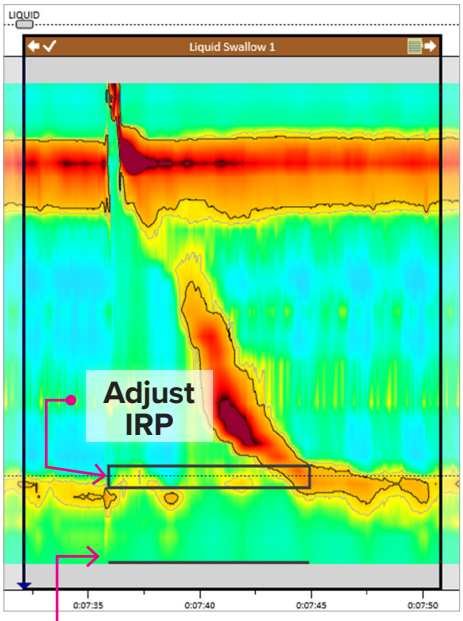
Starting with Zvu 3.4.0, analysis of Chicago data can be done using CCv3.0 rules and normal thresholds (or by default), or CCv4.0 rules or both. To select CC4.0 or both (CC3.0+CC4.0) click on the Properties page icon, expand the Analysis section, and select the desired analysis version.

Please refer to the Help section: Chicago Classification (CC) Metrics for more information on the analysis options.

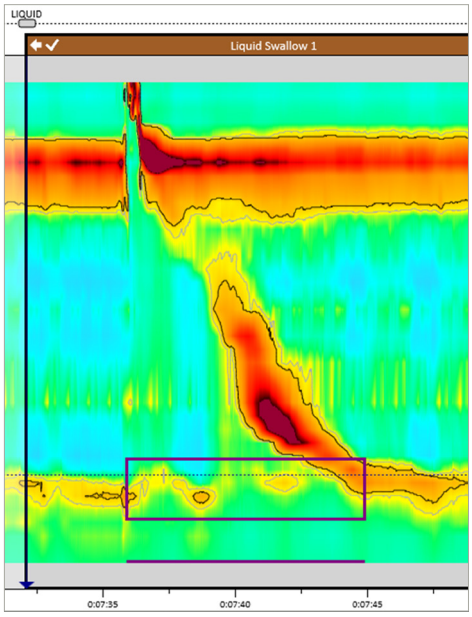
Chicago Analysis

Refer to the Chicago Classification publications for definitions of the various marks and metrics as well as associated normal thresholds.°†

Select the first **Swallow** thumbnail. Adjust swallow marks, if needed, as follows:



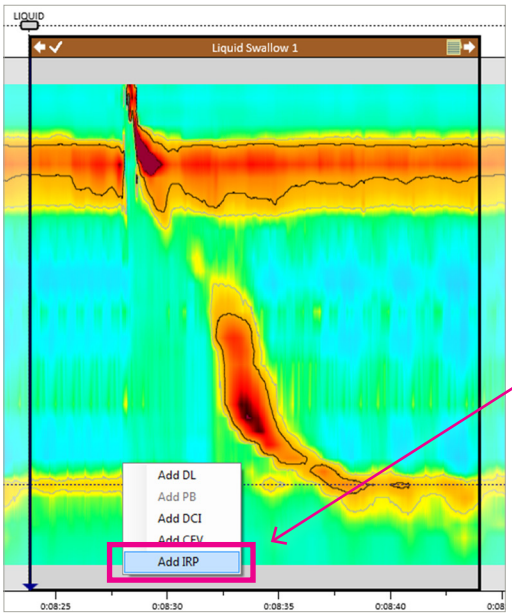
Gastric Reference Line

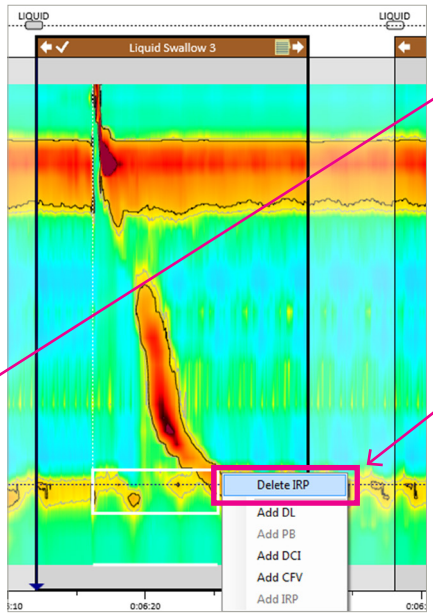


Corrected IRP

Integrated Relaxation Pressure (IRP):

- Adjust (click and drag) the right and left borders of the **IRP** box from the onset of swallow to the completion of the peristaltic wave or at least 10 seconds if no contraction is observed.
- Adjust the proximal and distal borders of the IRP box to include the entire length of the EGJ during the swallow if needed.
- Adjust the Gastric Baseline if needed to avoid areas of pressure.





- To add an IRP mark, make sure there is some gastric area below the EGJ on the probe bar. Right click in the swallow measurement. Select **Add IRP.**

Adjust the IRP box and Gastric Baseline if needed as instructed above.

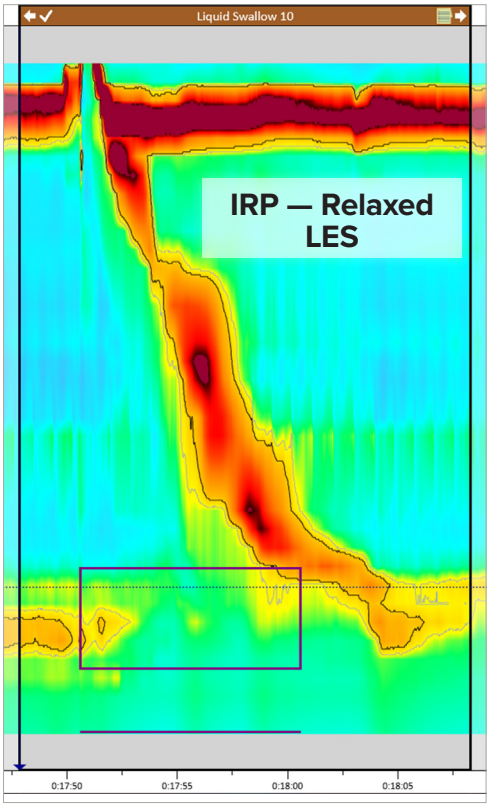
- To delete an IRP mark and the corresponding Gastric Baseline, right click on the mark and select **Delete IRP.**

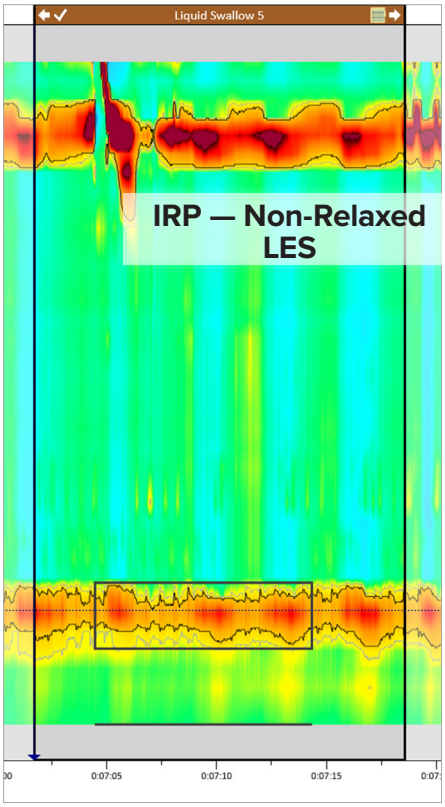
References

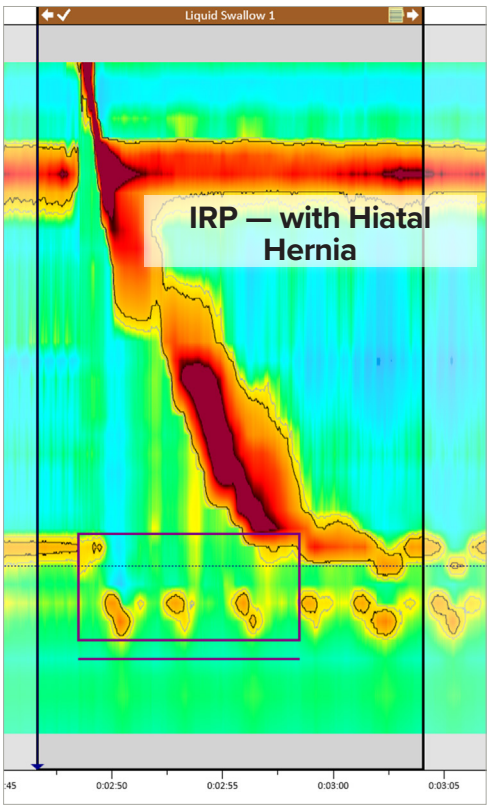
° Kahrilas PJ, Bredenoord AJ, Fox M, et al. The Chicago Classification of esophageal motility disorders, v3.0. Neurogastroenterol Motil. 2015;27;12477.

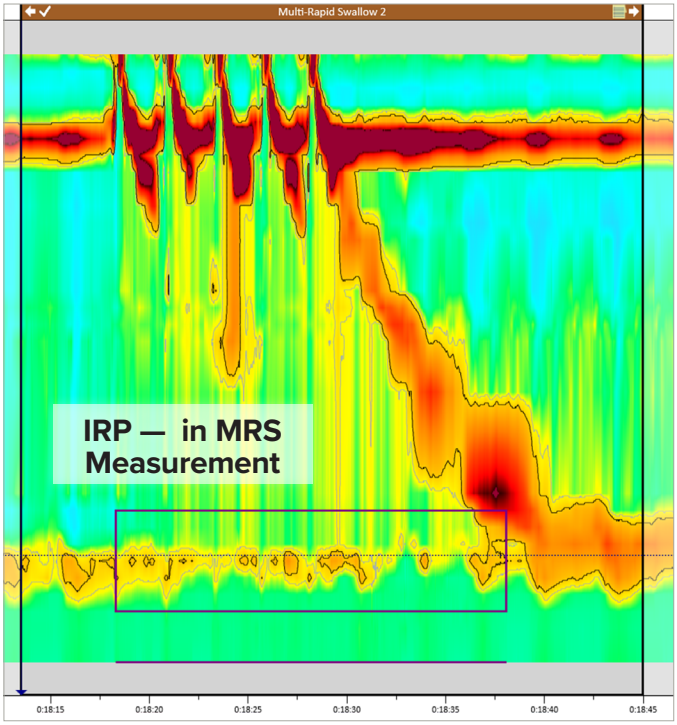
†Yadlapati, R, Kahrilas PJ, Fox MR, et al. Esophageal motility disorders on high-resolution manometry: Chicago Classification version 4.0©. *Neurogastroenterol Motil.* 2021;33:e14058. Along with 7 accompanying Technical Review articles (2021).

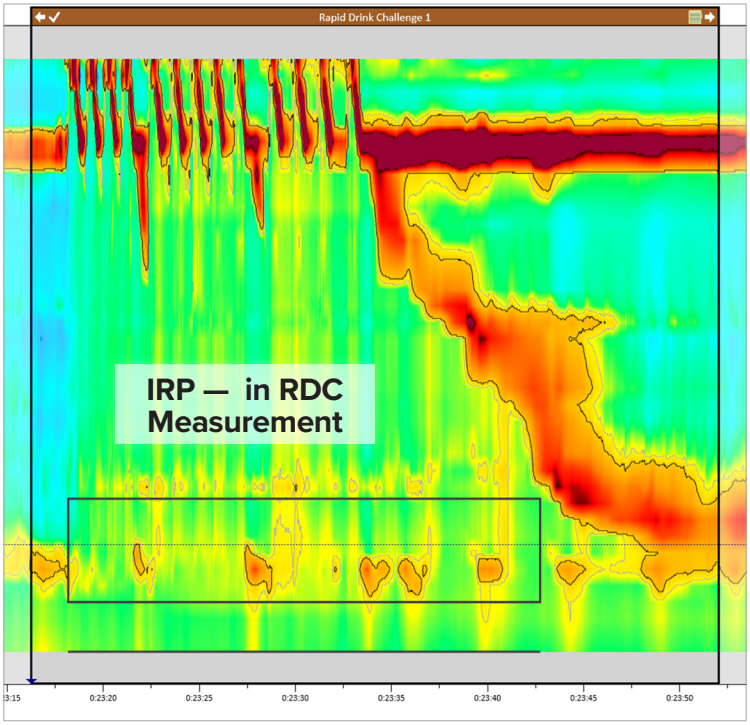
Examples of Different IRP Patterns



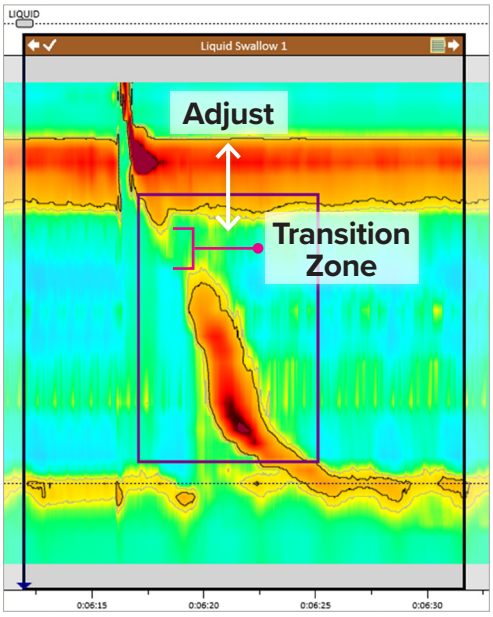


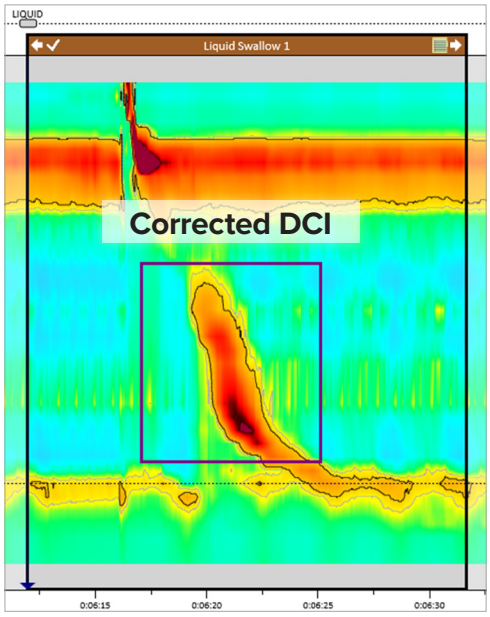






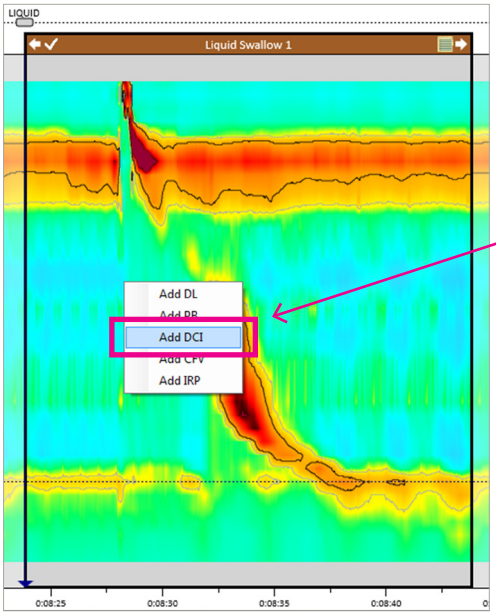
Chicago Analysis

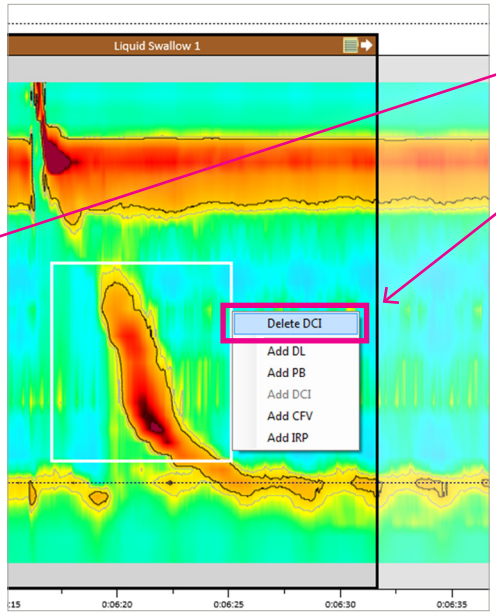




Distal Contractile Integral (DCI):

- Adjust (click and drag) the borders of the **DCI** box to encompass the peristaltic wave from the distal border of the transition zone to the proximal border of the LES.

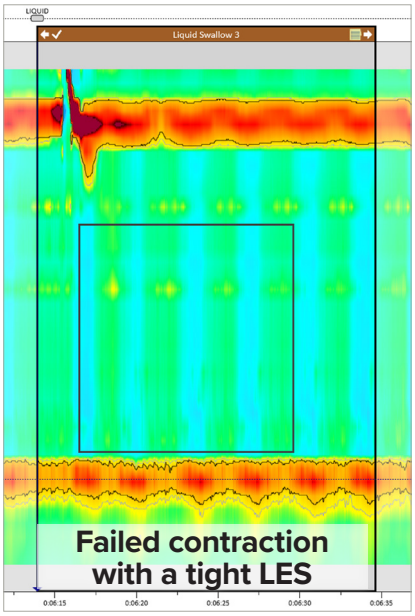


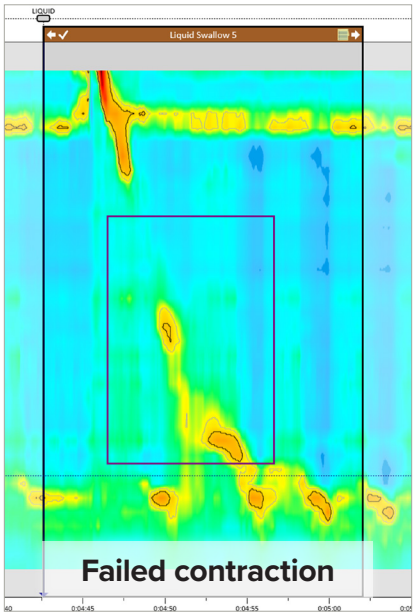


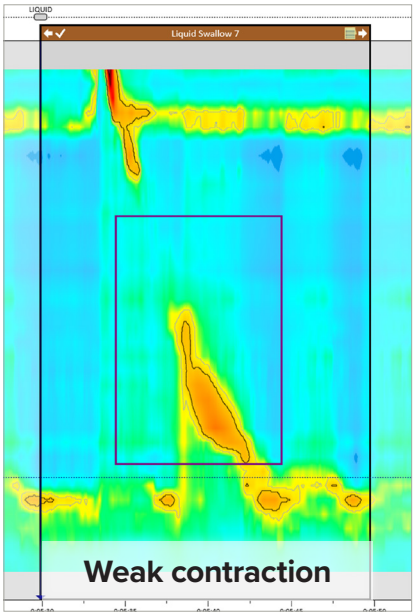
- To add a DCI mark, right click in the measurement and select **Add DCI.**
- To delete a DCI mark, right click on the mark and select **Delete DCI.**

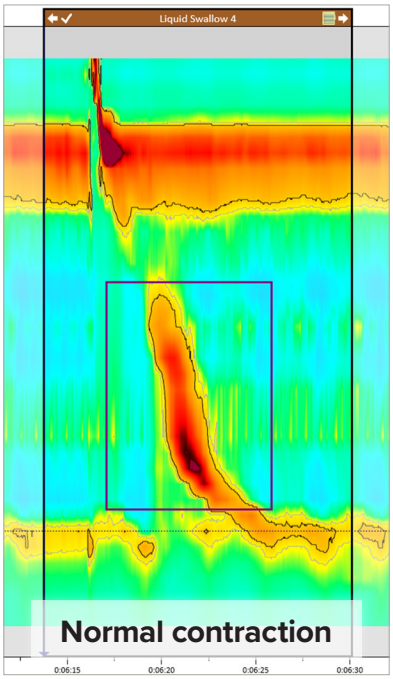
Chicago Analysis

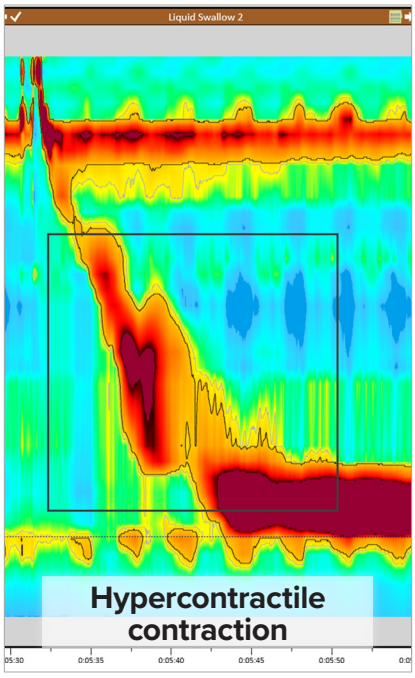
Examples of Different DCI Patterns



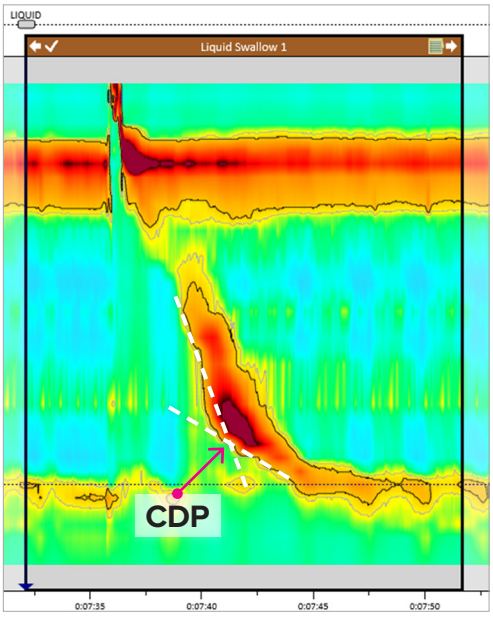


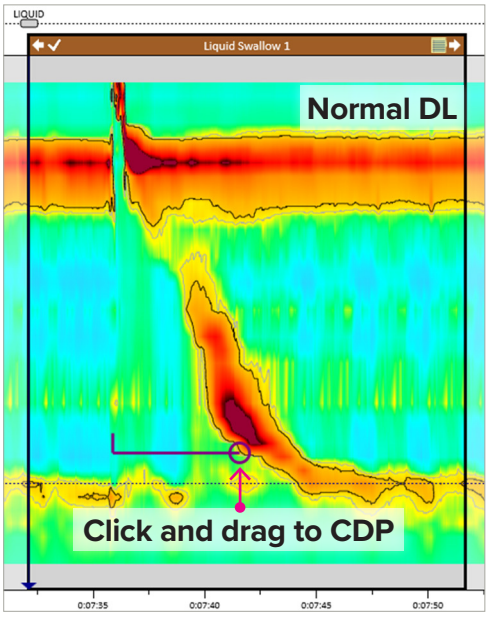






Chicago Analysis

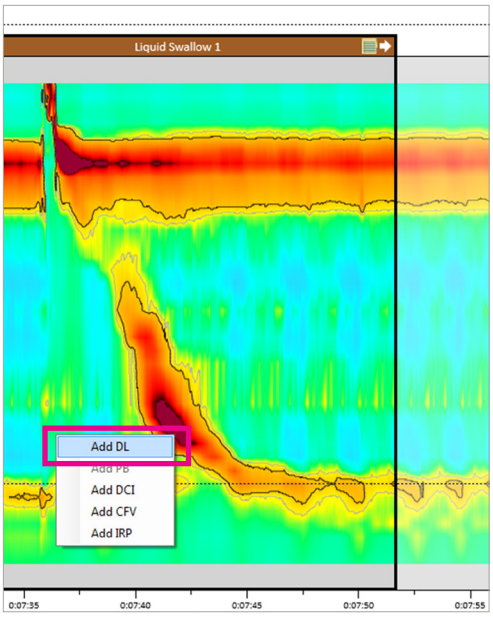




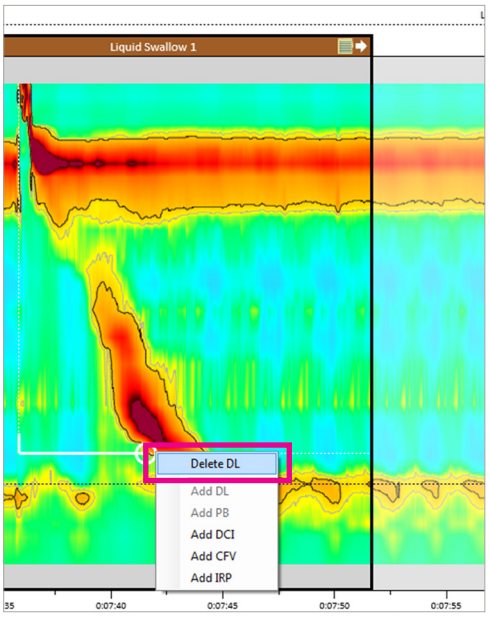
Distal Latency (DL):

- Adjust (click and drag) the DL from the initiation of swallow (UES start of relaxation) to the **Contractile Deceleration Point** (CDP) of the peristaltic wave using the 30 mmHg isobaric line (black).

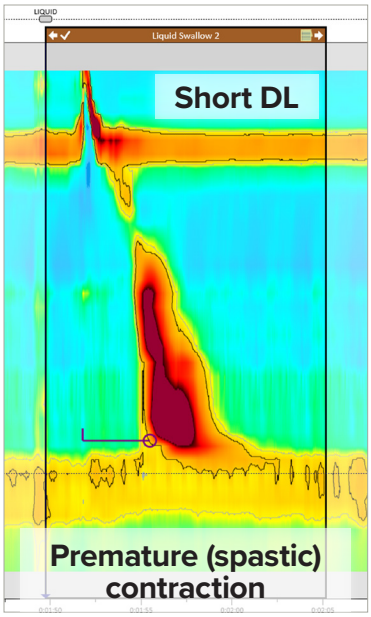
The CDP is identified as the point at which the front of the peristaltic wave slows to allow for esophageal emptying and where the tubular esophagus ends.



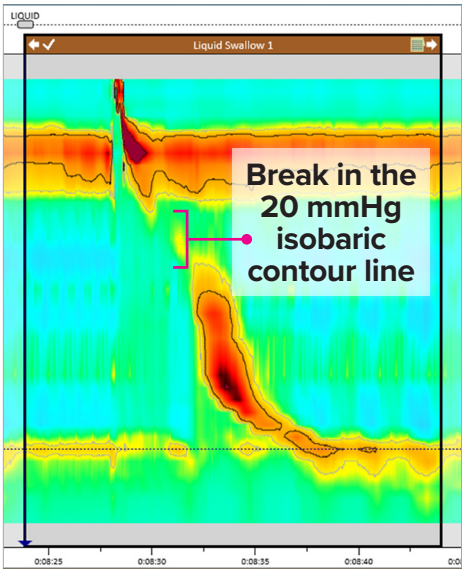
To add a DL mark, right click in the measurement and select **Add DL.**

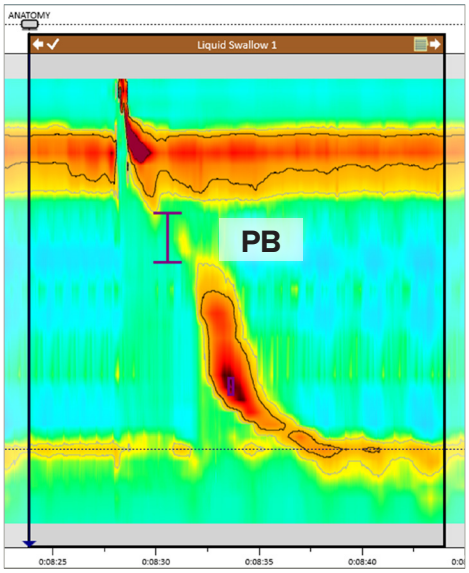


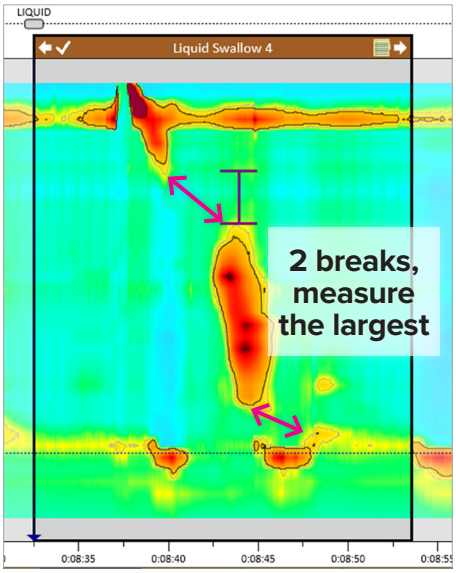
To delete a DL mark, right click on the DL mark and select **Delete DL.**



Chicago Analysis



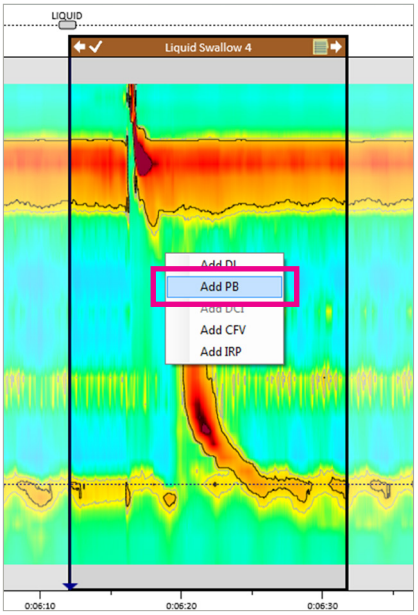


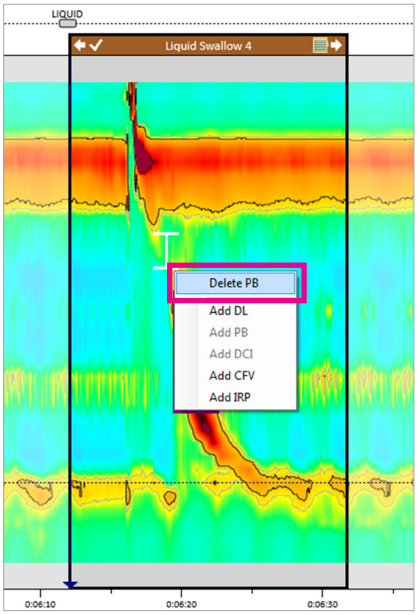


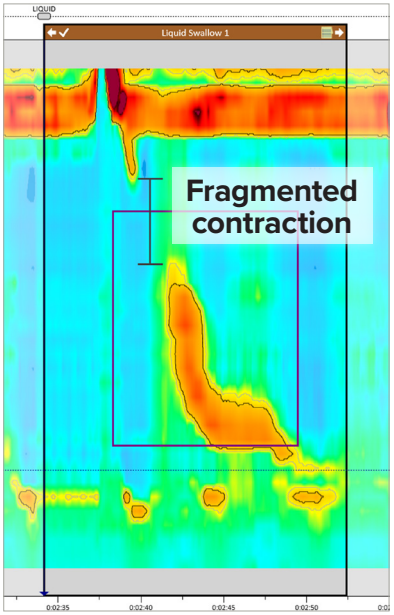
Peristaltic Break (PB):

A peristaltic break is defined as any point in the peristaltic wave where there is a break in the 20 mmHg isobaric contour line (gray). If more than 1 break is observed, adjust the PB to measure the largest break.

- Adjust (click and drag) the top and bottom edges of the PB from the proximal edge of the break in peristalsis to the point where peristalsis recovers using the 20 mmHg isobaric contour line (gray).





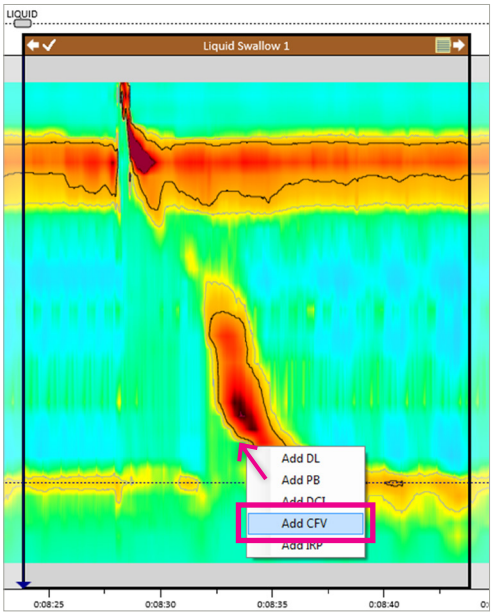


When the DCI is < 450 mmHg.s.cm, the PB is not needed (swallow is already ineffective).

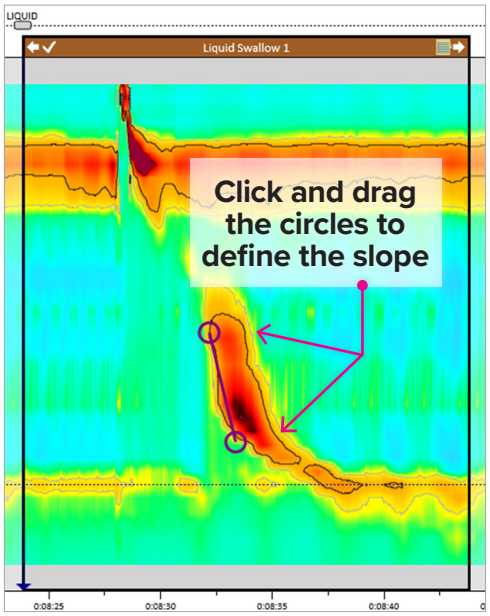
- To add a PB, right click inside the measurement area and select **Add PB.**
- To delete, select the PB, right click and select **Delete PB.**

Contractile Front Velocity (CFV):

Contractile Front Velocity is not a part of the standard parameters for the Chicago Classifications but can be added, if desired. CFV calculates the speed of the peristaltic wave in the distal esophagus by measuring the front slope along the 30 mmHg isobaric contour from the distal transition zone to the deceleration point.



- To add a CFV, right click inside the measurement area and select **Add CFV.** Adjust the slope to follow the front edge of the peristaltic wave from the distal edge of the transition zone to the deceleration point.



- To delete, select the CFV, right click and select **Delete CFV.**

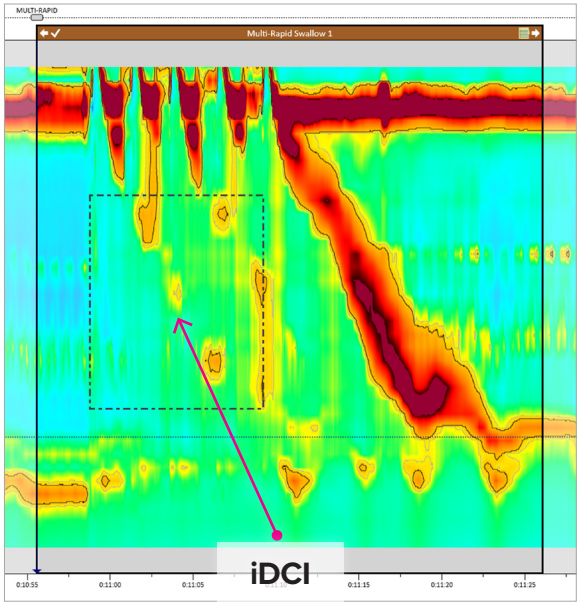
Evaluate and edit all Liquid Swallows. Do the same for additional swallow types.

Note: Viscous Pressure analysis is optional.

Click the **Save** icon.

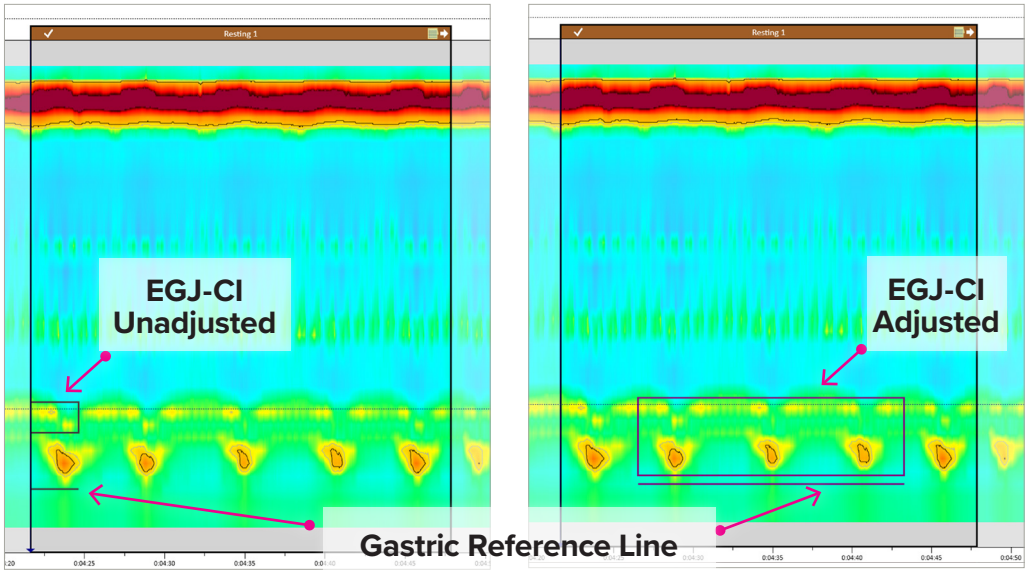
Chicago Analysis

New Chicago marks starting with Zvu 3.4.0 include iDCI, EGJ-CI, and IBP. The iDCI and IBP marks will only be available if CC4.0 analysis has been enabled through the Properties Page: Analysis. The EGJ-CI mark is available regardless of which Chicago analysis type is selected.



Inhibitory Distal Contractile Integral (iDCI):

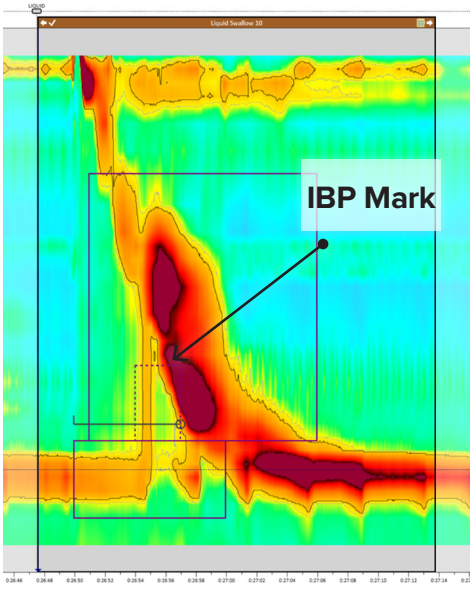
- The iDCI mark is specific to the Multiple Rapid Swallow (MRS) and the Rapid Drink Challenge (RDC) measurements. This mark covers the smooth muscle portion of the esophagus beneath the proximal pressure trough to the top of the LES during the drink period. The drink period spans from the start of the first UES opening to the start of the last UES opening.
- To adjust an iDCI mark, if needed, click and drag the desired border. To delete the iDCI mark, right-click on the mark and select Delete iDCI.



Esophagogastric Junction Contractile Integral (EGJ-CI):

- The EGJ-CI mark is available in supine and upright resting measurements. When adjusted, the EGJ-CI mark covers three respiratory cycles from the proximal LES to the distal diaphragm. The value is referenced to a gastric baseline of the same adjusted length.
- The EGJ-CI value will be --- until the mark is adjusted. To adjust the EGJ-CI mark, click and drag the borders. If no EGJ-CI value is desired, simply do not adjust the mark or right-click and select Delete EGJ-CI.

Chicago Analysis



Intrabolus Pressure (IBP):

The IBP mark is available for analysis beginning with Chicago Classification (CC) v4.0.

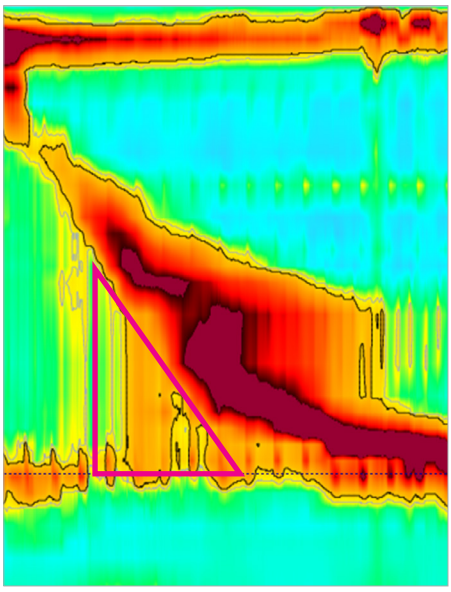
- The dashed rectangular IBP mark is available in various swallow measurements depending on the CC analysis selection made in the Properties page. The IBP mark can be added through the right-click menu if it is not already present. The intrabolus pressure (IBP) value quantifies the highest, constant intrabolus pressure within the mark's boundaries and can aid in identifying an intrabolus pressure pattern for a particular swallow.
- If panesophageal pressure is suspected (pressure vertically from the UES to the LES), adjust the IBP mark up to UES and across area of pressurization.
- To adjust the IBP mark, click and drag the borders. If no IBP value is desired, right-click on the mark and select Delete IBP.

Intrabolus Pressure Pattern (IBPP):

- The Intrabolus pressure pattern (IBPP) will respond to the IBP value. Alternatively, the IBPP can be set manually based on visual identification of a pattern.

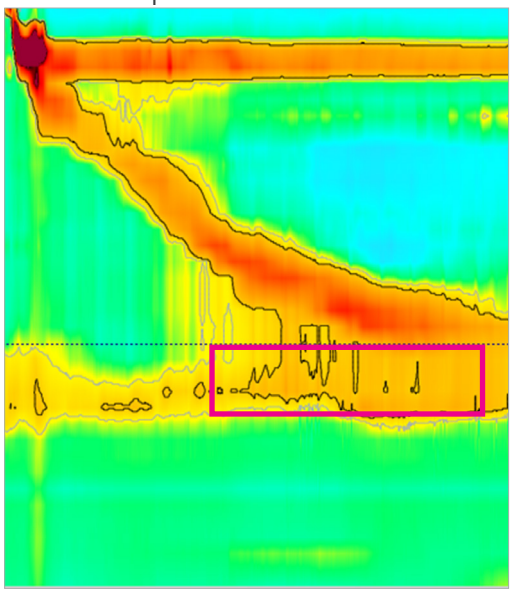
Compartmentalized Pressurization

Extending from the contractile front to the EGJ



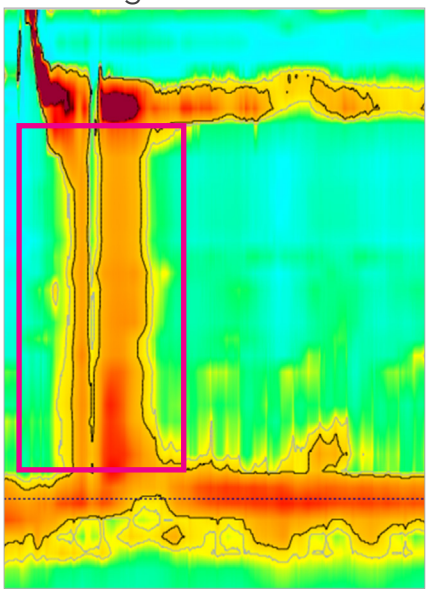
EGJ Pressurization

Restricted to the zone between the LES and CD in conjunction with LES-CD separation.



Panesophageal Pressurization (PEP)

Uniform pressurization extending from UES to the EGJ



Chicago Analysis

Hiatal Hernia

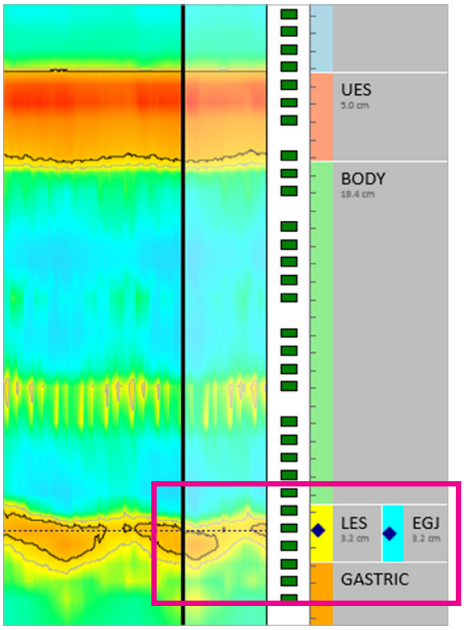
Hiatal Hernia can be described using EGJ Morphology when measuring the separation of the LES from the crural diaphragm (CD). EGJ Outflow Obstruction may be seen related to the mechanical obstruction derived from the hernia.

The CDP may be located at the proximal LES or within the boundaries of the LES.

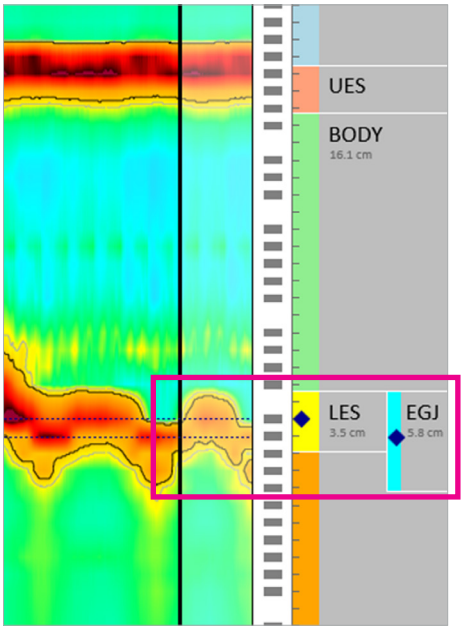
Metrics to define Hiatal Hernia:

- EGJ Morphology Type II or III.
- IRP median may be normal or may be elevated.
- EGJ pressurization may be present (IBPP).

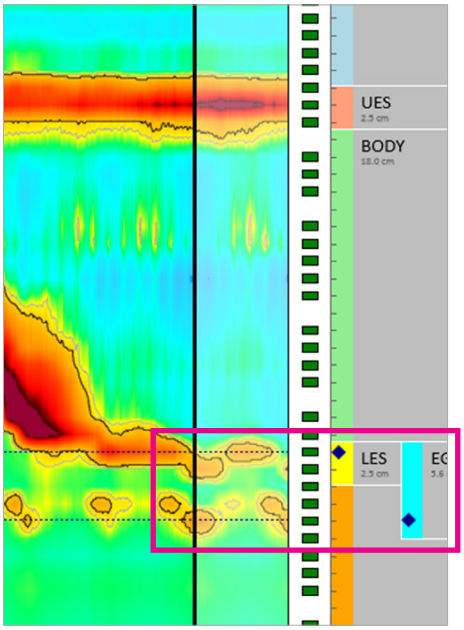
EGJ Morphology Type I
< 1cm separation between the HPZ of the LES and HPZ of the CD



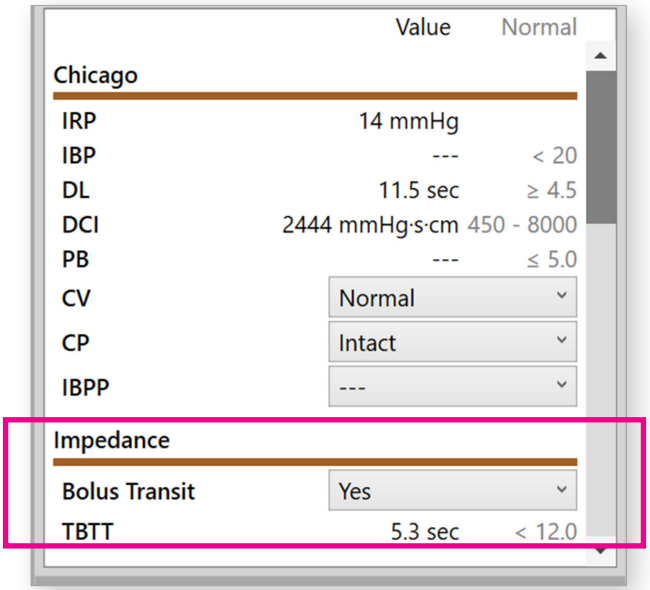
EGJ Morphology Type II
1–2cm separation between the HPZ of the LES and HPZ of the CD



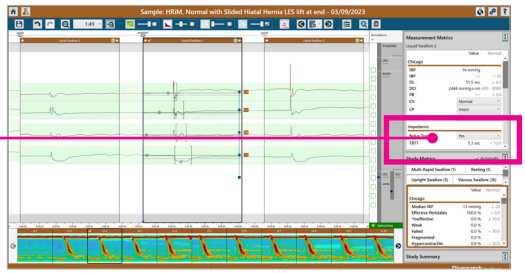
EGJ Morphology Type III
> 2cm separation between the HPZ of the LES and HPZ of the CD

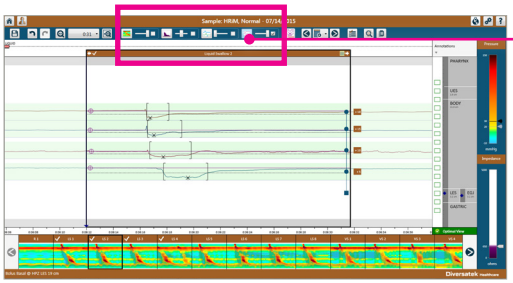


Bolus Transit Analysis



The **Impedance** values are displayed below the Chicago values in the **Measurement Metrics.**

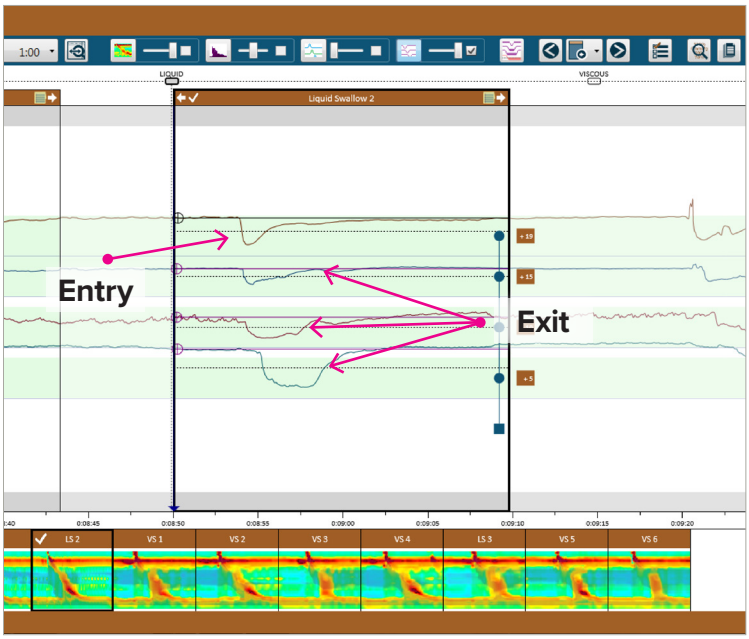




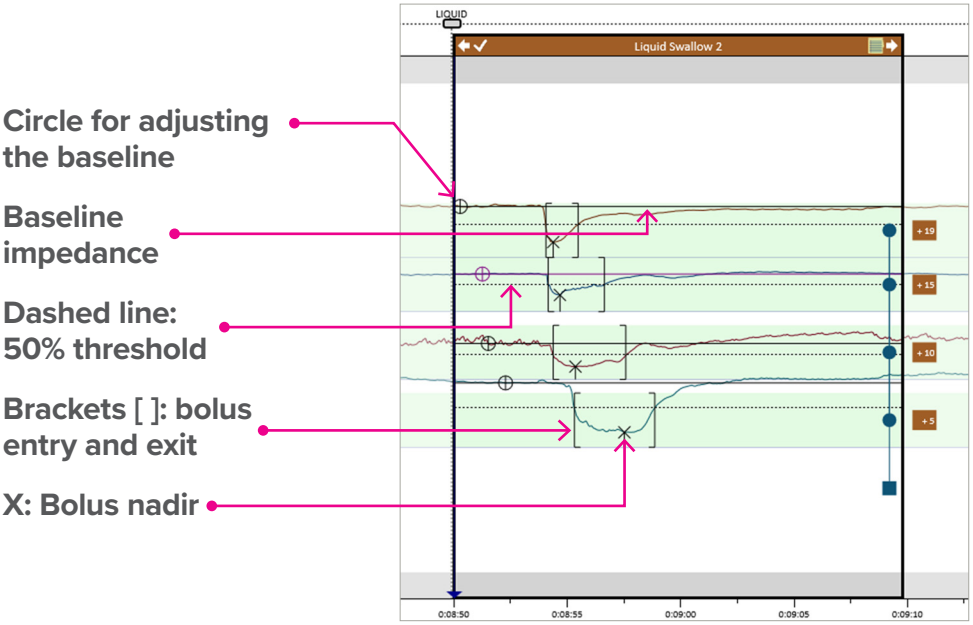
Turn off Pressure Contour, Impedance Contour and Pressure Waveforms. Turn on Impedance Waveform. Select the first Liquid Swallow thumbnail.

Impedance Waveform Analysis

Impedance Rules for Complete Bolus Transit



1. The bolus must have an entry in the proximal impedance waveform—the wave drops below the 50% threshold (dotted line) of the baseline.
2. The bolus must exit in the distal 3 waves—each wave rises above the 50% threshold (dotted line) of the baseline and remains above for at least 5 seconds.
3. The bolus must accomplish Complete Bolus Transit within 15 seconds of the original entry.

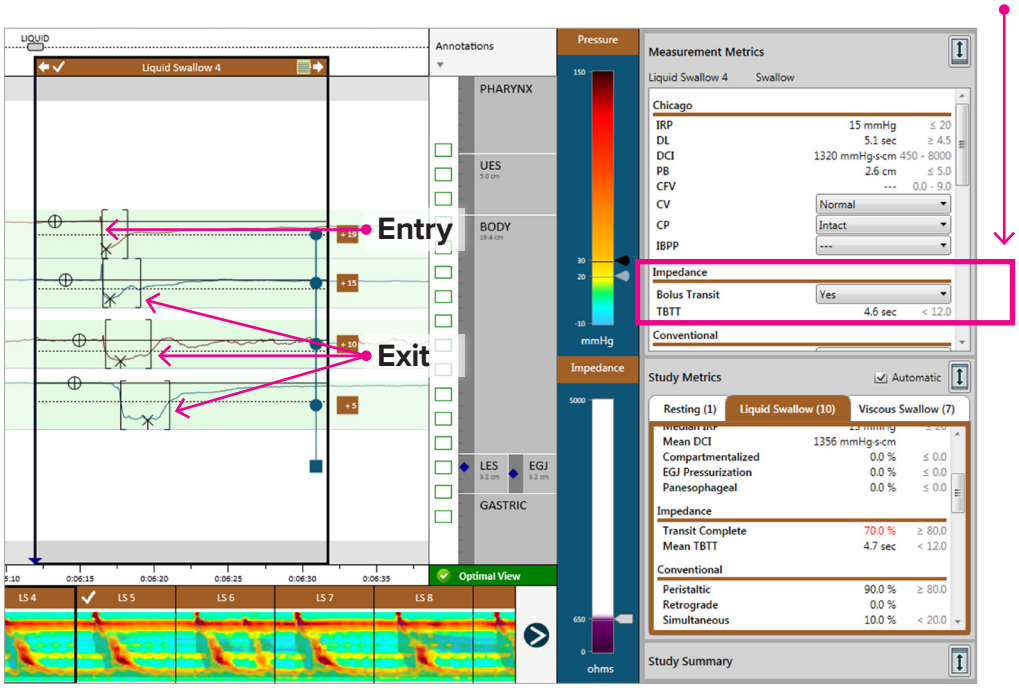


In the Measurement Metrics window, view Impedance transit values.

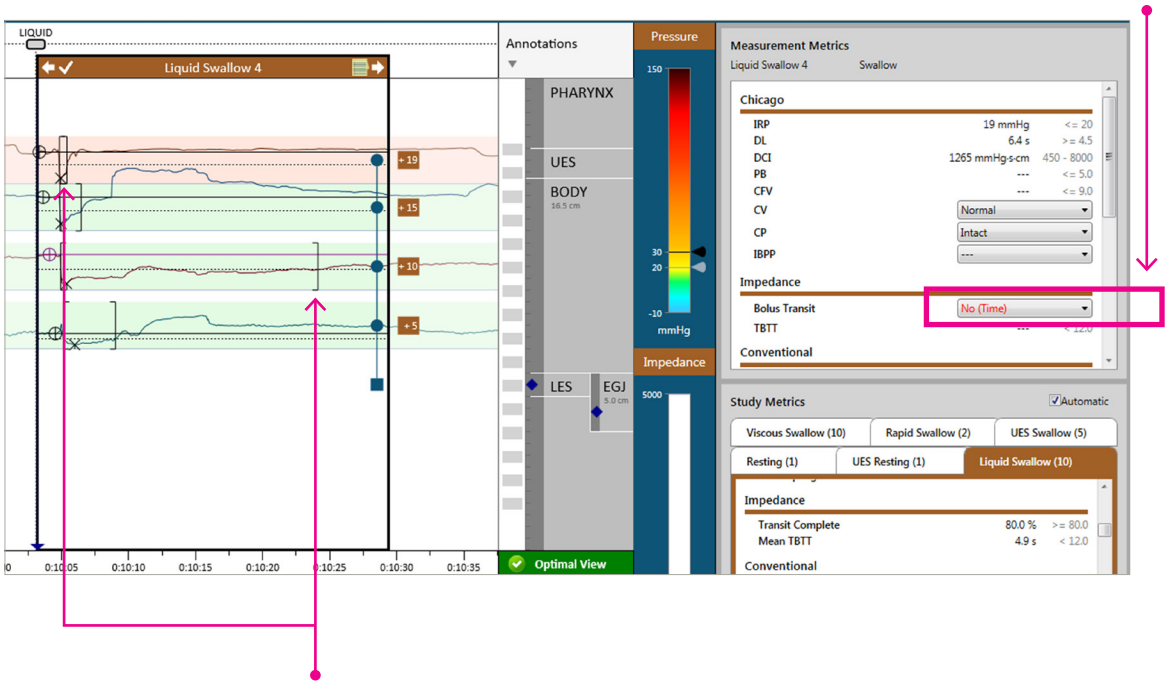
Evaluate each Impedance measurement (Liquid and Viscous).

Impedance Waveform Analysis

When Transit reads **Yes,** review the marks for accuracy. Editing may not be necessary.



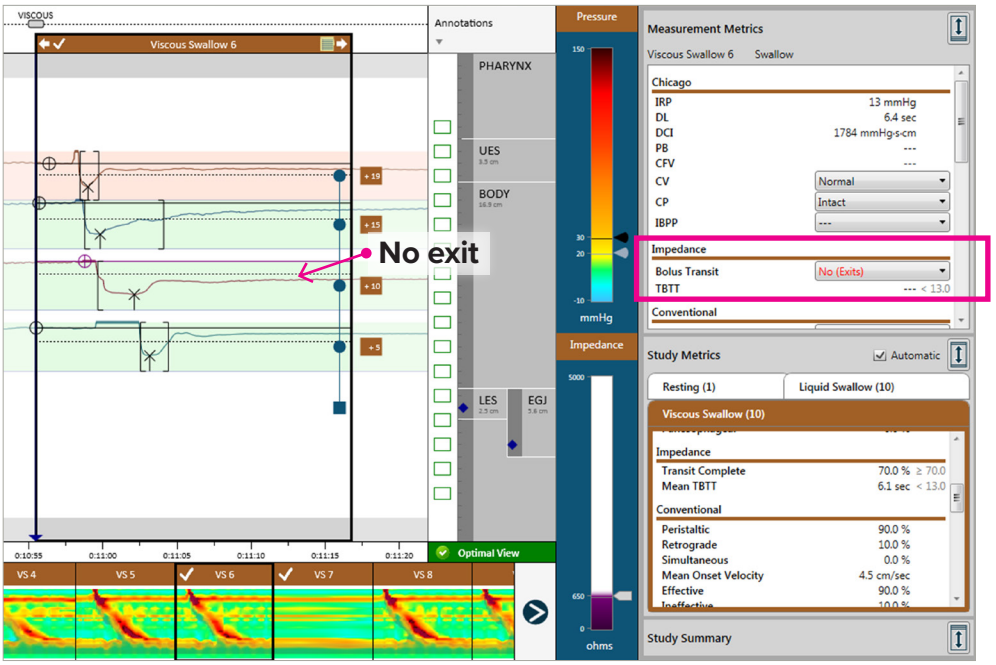
When Transit reads **No Time**, review the marks for accuracy. Editing may not be necessary.



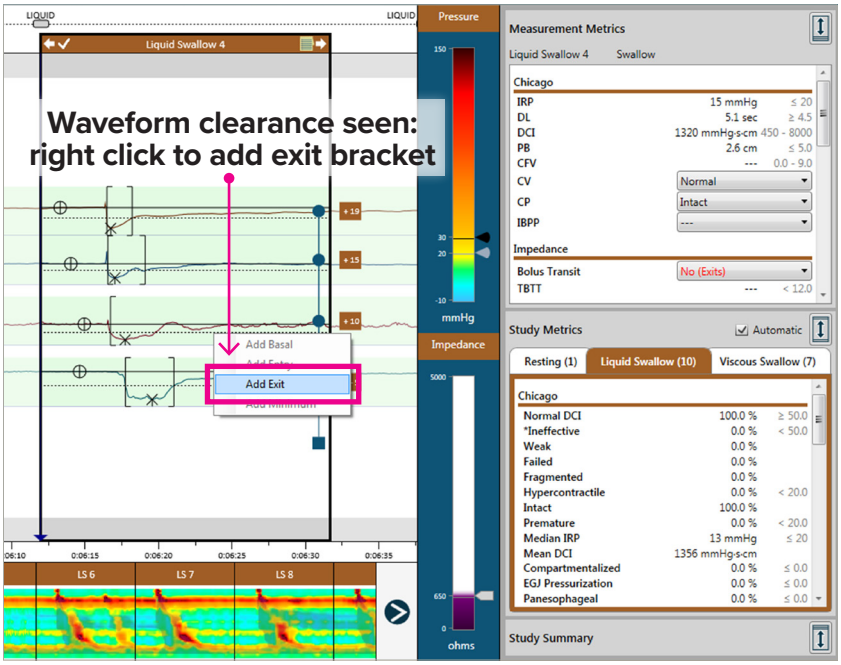
No (Time) = Exit in one of the 3 distal lanes occurred more than 15 seconds after the Entry in the first lane

Impedance Waveform Analysis

When Transit reads **No (Exits),** verification is required. If an exit is not observed and a distal waveform fails to clear 50% threshold, no editing is required.



If a waveform rises above the 50% threshold and stays above for at least 5 seconds, an exit should be added.



Point cursor to the observed exit point. Right click and select **Add Exit.**

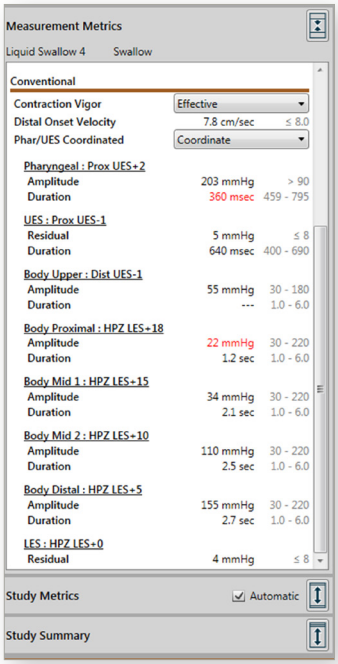
Click and drag the added Exit mark to adjust its location, if needed.

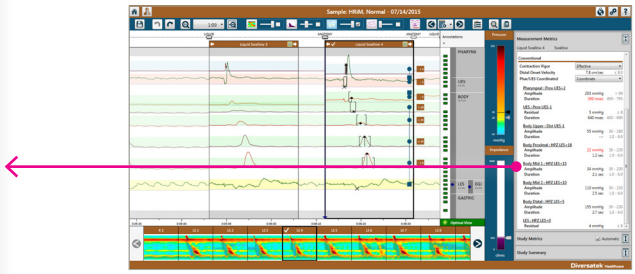
Evaluate and edit all Liquid and Viscous Swallows.

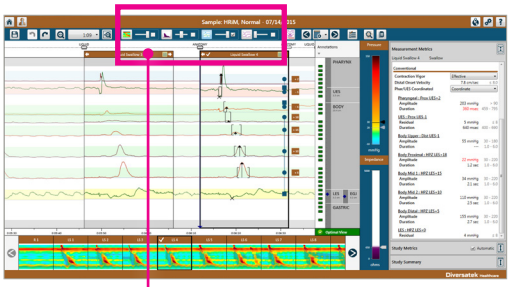
Click the **Save** icon.

Waveform Analysis

To view Conventional pressure values, scroll to the bottom of the **Measurement Metrics** window if needed.







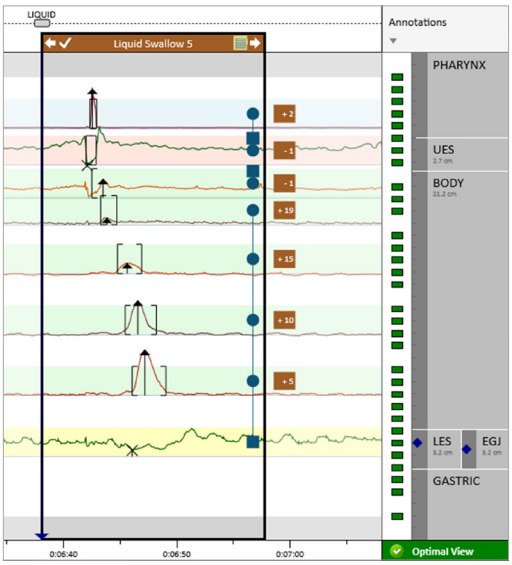
Off **Off** **On with check mark** **Off**

Turn off Pressure and Impedance Contours and Impedance Waveforms.
Turn on Pressure Waveforms.

Conventional Analysis

Select the first **Liquid Swallow** thumbnail.

The waveform lanes activated are based on the probe bar adjustment of the HPZ of the LES made in the Resting or first Liquid Swallow Measurement (the first measurement in the study).



Pharyngeal waveform: 2cm above the proximal border of the UES (+2)

UES waveform: 1cm below the proximal border of the UES (-1)

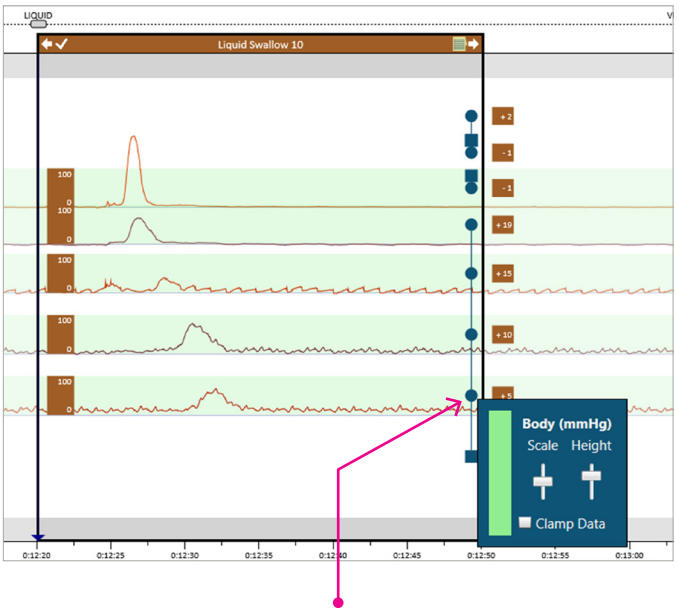
Striated body waveform: 1cm below the distal border of the UES (-1)

Body waveforms span 4 positions at 5, 10, 15, and 19cm above the HPZ of the LES (+5, +10, +15, +19)

LES waveform: at the HPZ of the LES.

Right click on a blue dot on the right of the measurement. Select **Height** to double the height of the lanes in a region. Click on **Scale** until the desired scale is displayed.

Check the **Clamp Data** box to prevent the waveforms from overlapping, if desired.



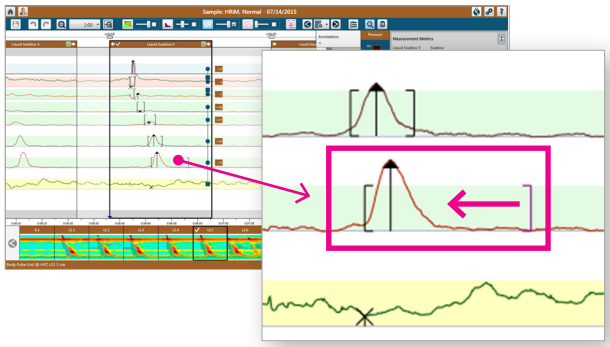
Right click on the waveform dot to adjust Scale or Height

Conventional Analysis

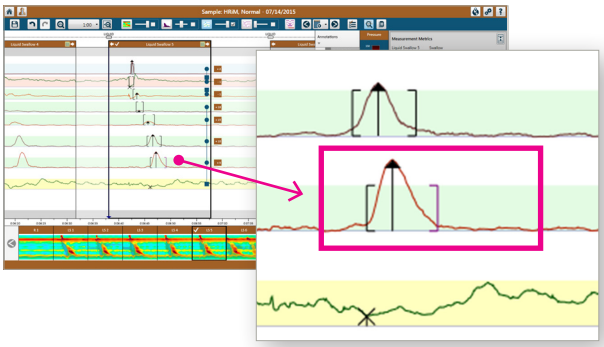
1. Adjust the brackets for all Body Waveforms as follows:

Click and drag the left bracket **[** to the upslope of the contraction, and the right bracket **]** to the downslope of the contraction.

Magnify the screen as needed by left clicking on the area of interest and scrolling the mouse wheel forward. Pull the wheel back to zoom out again.



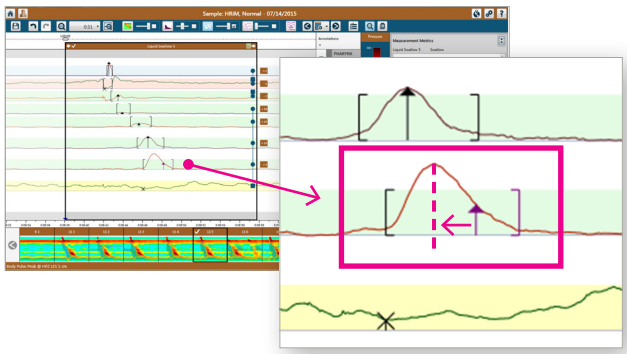
Body Bracket] to adjust



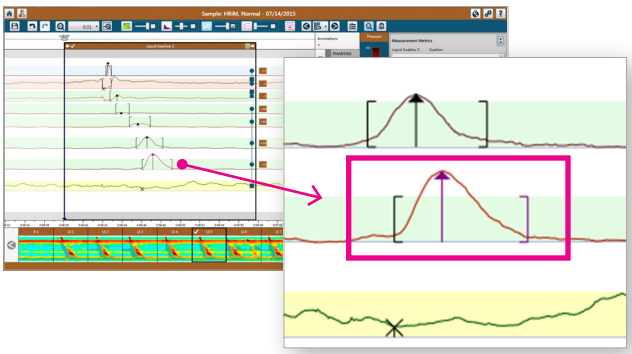
Body Bracket corrected

2. Verify the placement of each amplitude marker (↑) in each Esophageal Body waveform as needed at the peak of contraction. Click and drag to desired location.

Note: The amplitude marker will follow the waveform as it is moved.



Body Peak ↑ to adjust



Body Peak corrected

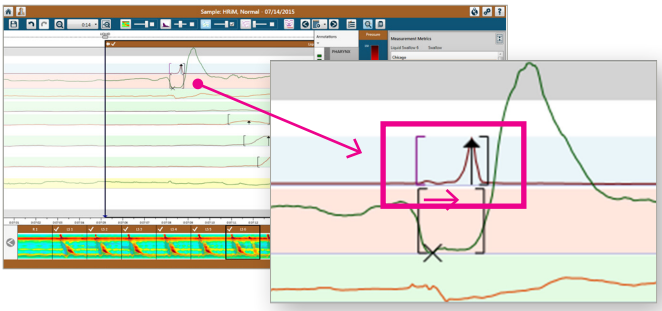
3. Adjust (click and drag) the LES Nadir marker **X** on the LES waveform to the lowest point of relaxation, smoothing the curve and avoiding respiratory artifact.

LES Nadir X to adjust

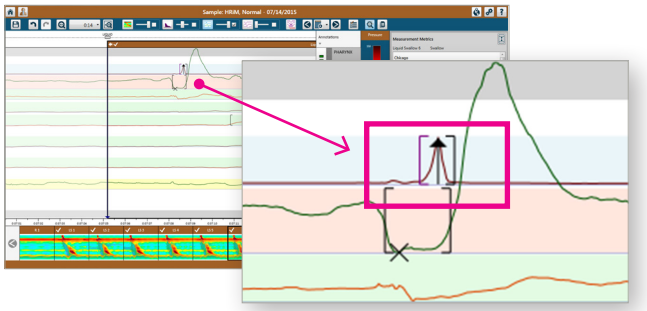
LES Nadir corrected

Conventional Analysis

4. Adjust the brackets **[ ]** and peak ↑ of the Pharyngeal Waveform in the same way as the other Body marks were adjusted.



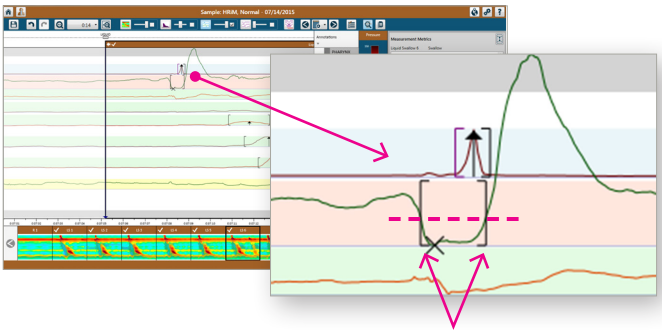
Pharyngeal Bracket [to adjust



Pharyngeal Bracket corrected

5. Correct the UES relaxation markers:

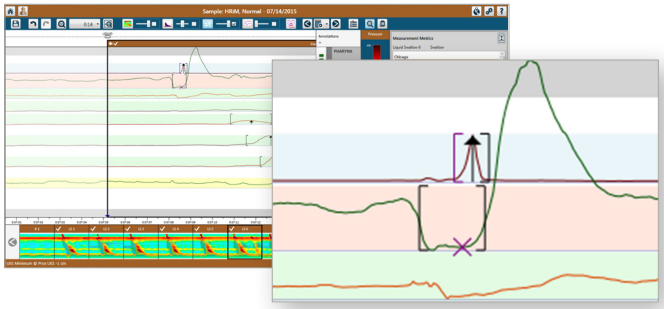
   a. The left bracket **[** is positioned at the downslope of the relaxation and the right bracket **]** is positioned at the upslope of the sphincter closure.



UES Relaxation Brackets

   a. Adjust (click and drag) the UES Relaxation Nadir marker **X** in the UES waveform to the lowest point of relaxation, smoothing the curve and avoiding the initial drop in pressure.

UES Nadir X to adjust



UES Nadir corrected

Note: Review Measurement Metrics for each swallow.

Evaluate and edit all **Liquid Swallows.**

Note: Viscous Pressure analysis is optional.

Click the **Save** icon.

Appendix


Zvu Home Screen


Language Selection for Study Review


Help Resources


Patient Management


Download a Study (Reflux Study Data)

Import a Study from External Storage Media

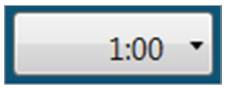
Export a Study to External Storage Media


Save


Undo Last Action


Redo Last Action


Zoom In



Time Scale

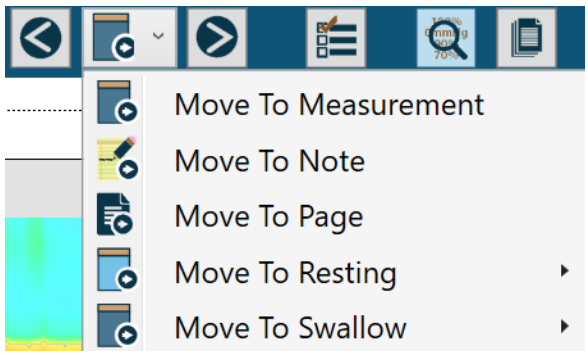

Zoom Out to The Full Study

Pressure contour icon/slider bar and analysis mark checkbox: The slider bar adjusts the pressure contour opacity. The icon (image) turns on/off the display at the set opacity level. A check in the checkbox shows the pressure contour analysis marks (Resting baselines and Chicago analysis marks).

Impedance contour icon/slider: The slide bar adjusts the contour opacity level. The icon (image) turns on/off the contour display at the set opacity level.

Pressure waveform icon/slider bar and analysis mark checkbox: The icon (image) or the slider bar turns on/off the pressure waveform display. A check in the checkbox shows the pressure waveform analysis marks.

Impedance waveform icon/slider and analysis mark checkbox: The icon (image) or the slider bar turns on/off the impedance waveform display. A check in the checkbox shows the impedance waveform analysis marks.



Move To icons navigate the study by a selected feature.


Options


Metrics


Reports

Notes

Innovations in Clinical Education

Diversatek Healthcare offers a variety of sources to learn more about our technology, covering:

- MiVu™ Mucosal Integrity Testing
- Zvu® Esophageal Manometric Studies
- BioVIEW® Anorectal Manometric Studies
- Zvu® Impedance/pH Reflux Monitoring Studies

Diversatek™ University On-Demand

Our newly enhanced on-demand training and education platform contains free content on all Diversatek studies and testing systems. Included are tutorials providing step-by-step guidance to develop skills in data acquisition, study review and report generation. Visit **Diversateku.com** for full access.

Denver Training Center

Our Technical Research & Training Center offers a number of product training courses to provide clinical users with the knowledge and skills necessary to effectively acquire and analyze studies. Email us at **clinicaleducation@diversatekhc.com** to learn more about our Denver course offerings.

Webinars

Diversatek Healthcare is proud to present a series of live, interactive discussions on topics related to Diversatek technology. Each webinar includes a didactic session followed by an open discussion. All webinars are recorded and posted in Diversatek University for easy reference. Visit **Diversateku.com** to access an archive of our most popular webinars.

Personalized Training

Onsite Training

Diversatek Healthcare Clinical Specialists deliver product support to suit your specific needs — on your schedule. Specialists are onsite at your facility to train and support you on your Diversatek Healthcare technology. Training is conducted as you work through patient cases, acquire and analyze patient data, and create patient reports.

Virtual Coaching

Online and in real-time, Diversatek Healthcare Clinical Specialists work with you via screen sharing to provide study-specific data review and report generation coaching for your more difficult studies.

Email us at **clinicalsupport@diversatekhc.com** to schedule an onsite or virtual session.

Diversatek™ Healthcare

Advancing GI care by driving science, developing and delivering solutions, and providing unmatched clinical support.

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