

Introduction

Cardiovascular diseases (CVDs), including heart failure, are the most common causes of death in the United States¹. Heart failure is characterized by a structural remodeling of contractile proteins and lipids impacting cardiac^{2,3}. It is unknown how lipid remodeling contributes to disease pathology and differs between anatomical regions of the heart. Therefore, we obtained spatially resolved lipid profiles of different anatomical regions within the healthy human heart using matrix assisted laser desorption/ionization mass spectrometry imaging (MALDI MSI). Our goal is to obtain lipid profiles to link structural changes with cardiac function.

MALDI MSI

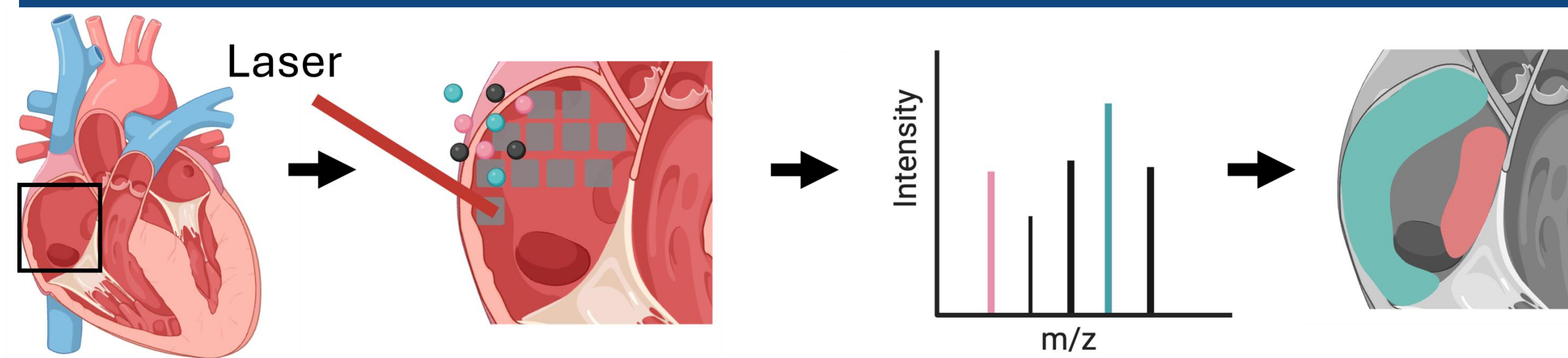
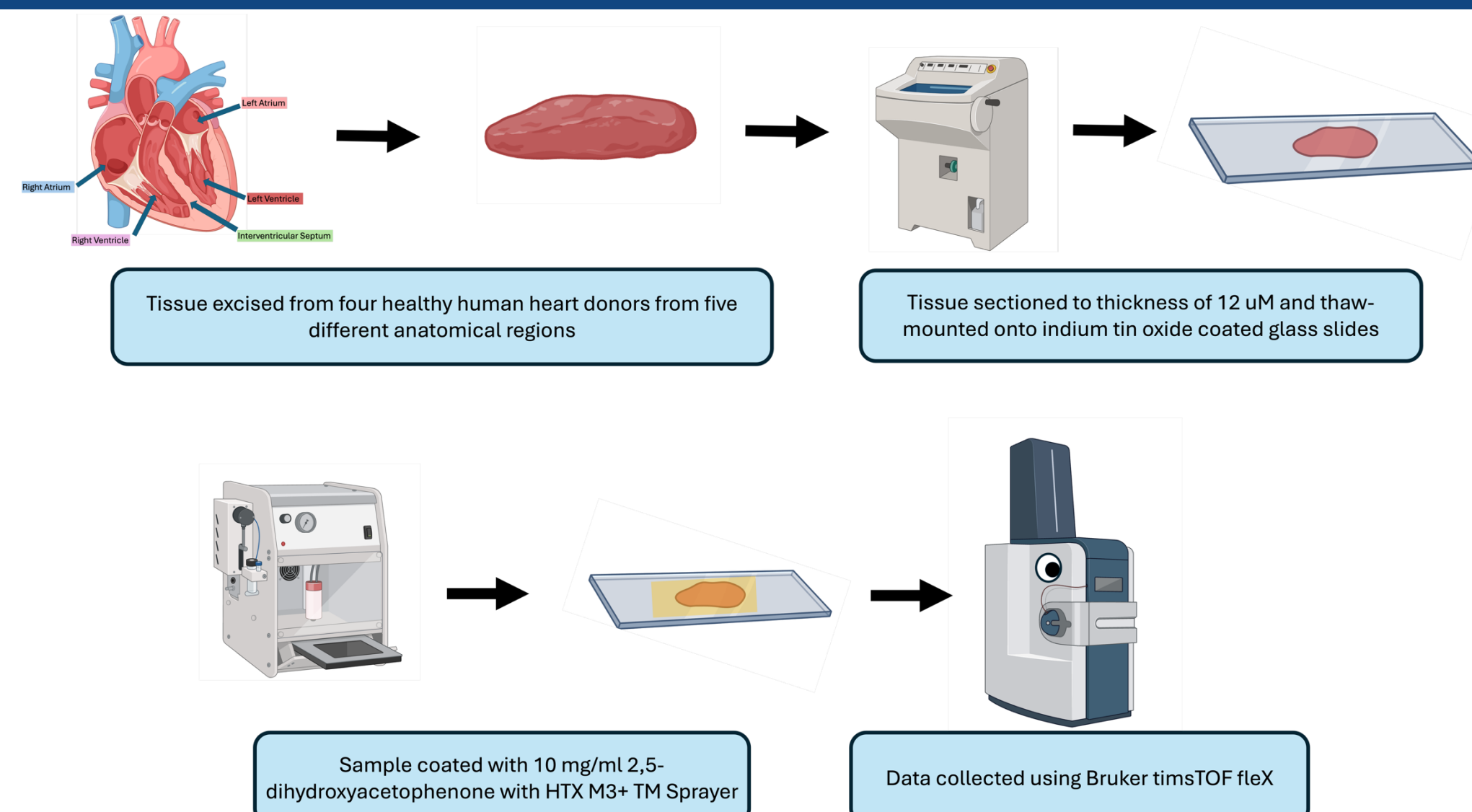


Figure 1. MALDI MSI schematic. The sample is rastered in micrometer increments and mass spectrum are taken at each point. This data can be then visualized to show ion abundance and distribution.

MALDI MSI allows us to obtain spatially preserved lipid profiles as the tissue is rastered along specific increments, obtaining a mass spectrum at each raster point⁴. **This technique allows us to not only identify lipids but also determine localization of specific lipids within the heart regions.**

Sample Preparation



Lipid Profiles of Human Heart Regions

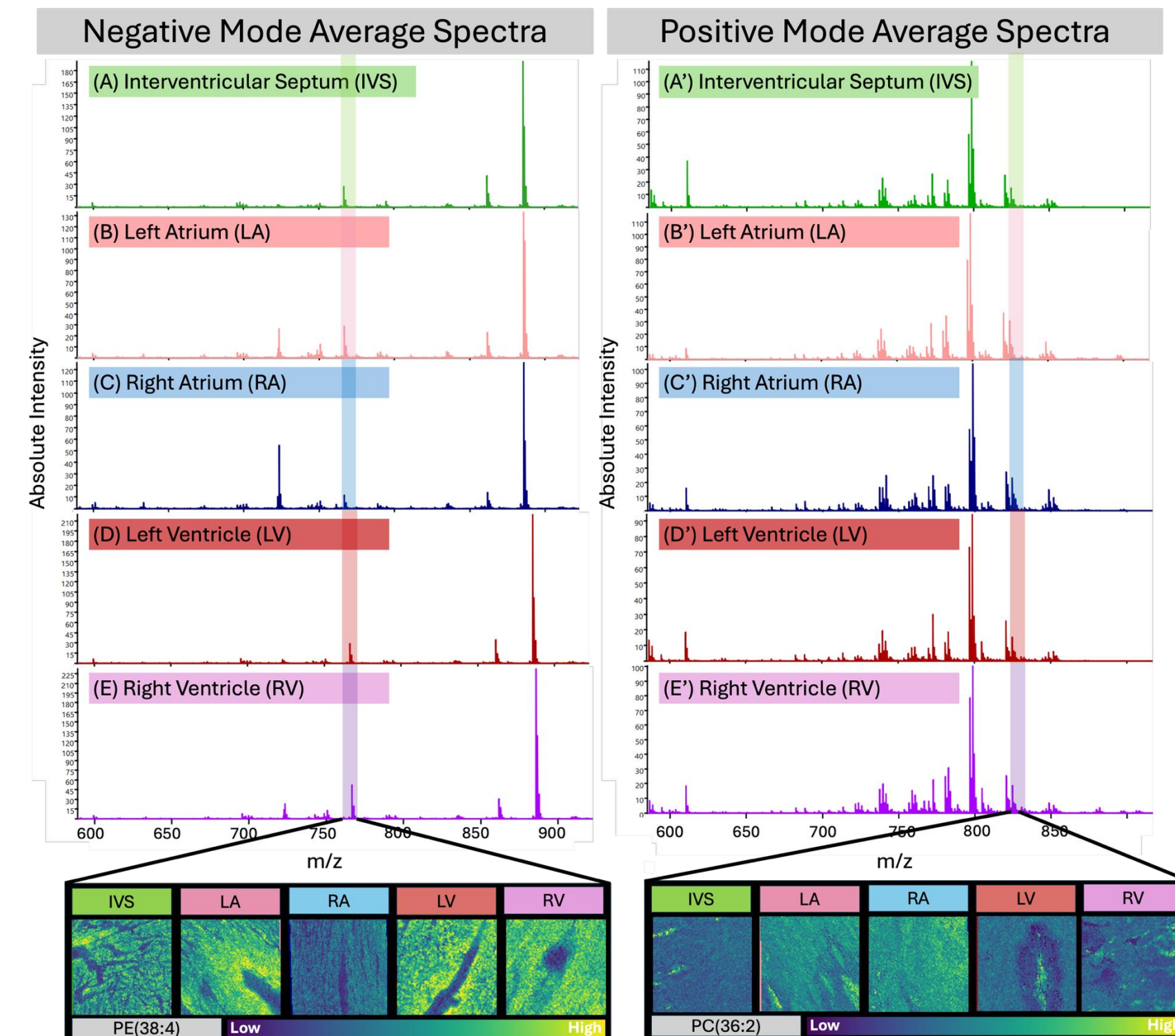


Figure 2. Average spectra of regions. A-E represents the negative mode average spectra whilst A'-E' represent the positive mode average spectra of the four donor samples. The peak highlighted in the negative mode spectra represents lipid PE(38:4). The peak highlighted in the positive mode spectra represents lipid PC(36:2). Ion images are taken from the corresponding m/z and from each of the five anatomical regions.

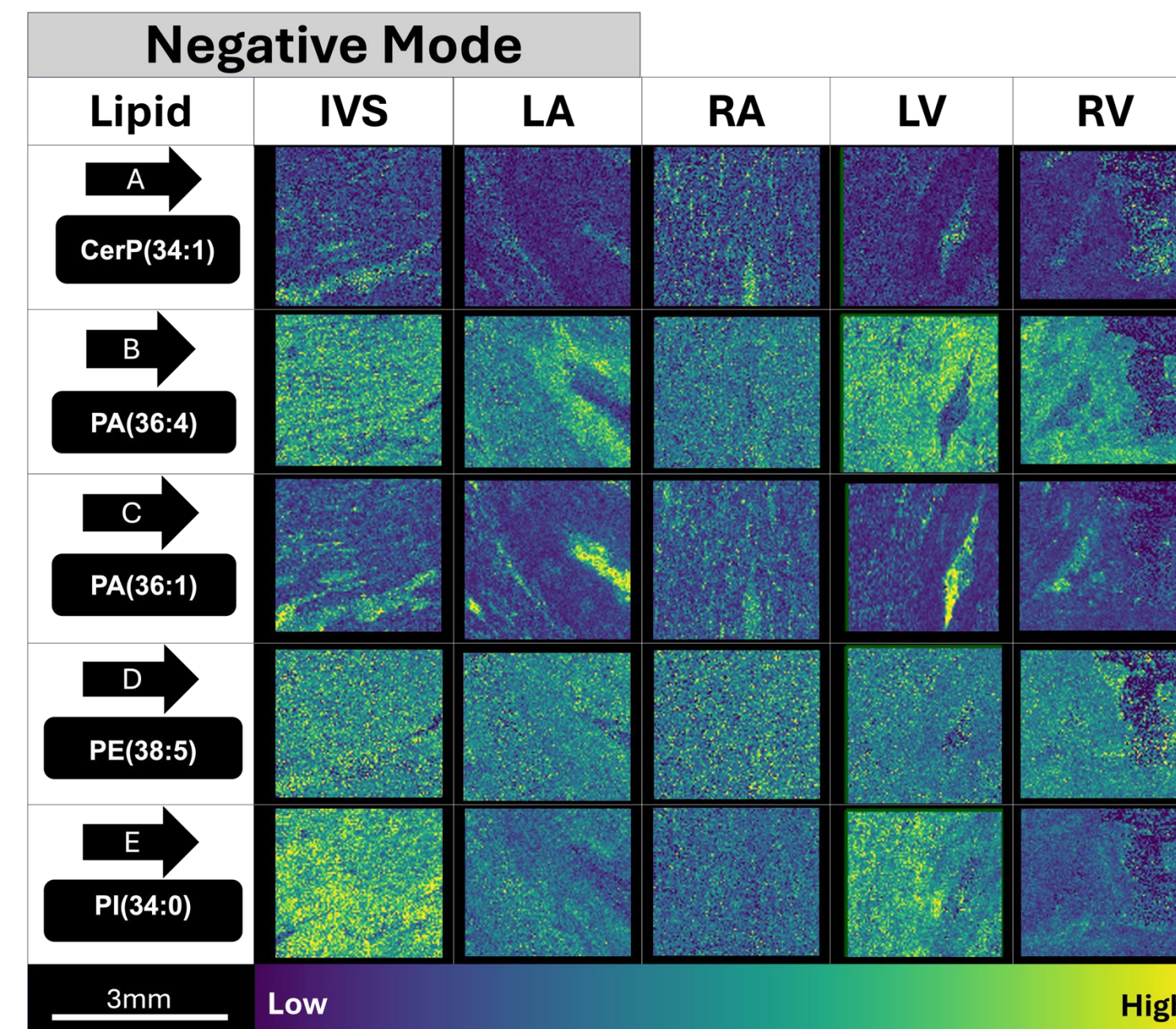
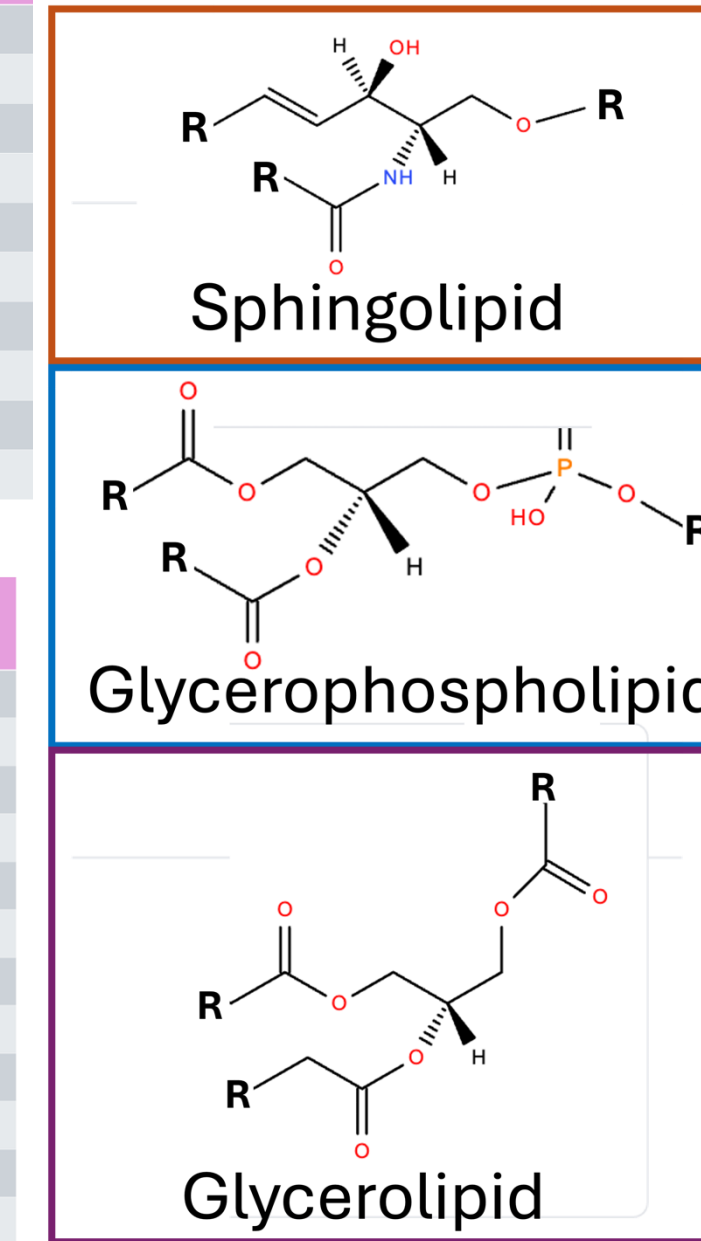


Figure 4. Ion images of five heart regions. A-E represent negative mode ion images, A'-E' represent positive mode ion images. Five representative lipids chosen for both modes and ion images at corresponding m/z shown for each of the five heart regions (IVS, LA, RA, LV, and RV).

Negative Mode					
Lipid Class	IVS	LA	RA	LV	RV
CerP	3	3	4	4	2
CerPE	2	2	2	2	2
SHexCer	-	1	-	-	1
PA	13	17	13	16	16
PE	18	21	16	17	23
PG	4	3	3	4	3
PS	12	15	13	15	14
PI	12	11	15	12	15
DG	-	1	-	-	1
Total:	64	74	66	70	77

Positive Mode					
Lipid Class	IVS	LA	RA	LV	RV
CerP	3	-	-	2	2
CerPE	5	4	2	1	3
SHexCer	2	4	-	-	2
Hex2Cer	-	-	-	-	1
SM	6	7	9	4	2
PA	17	9	8	11	21
PE	5	4	9	7	6
PG	8	8	16	12	9
PS	2	5	9	10	23
PI	3	3	3	6	2
PT	-	4	6	-	-
DG	-	-	-	5	3
TG	-	-	1	-	-
Total:	51	48	63	58	69

Figure 3. Overview of lipid class identifications. Tables on the left indicate classes of lipids putatively identified as well as number of each lipid class identified in each heart region. On the left is generic lipid structures of each category of lipid identified⁵.



Conclusion

- **Anatomical heart regions differ greatly in lipid composition and distribution**
- Functional regions in the heart are defined by their phospholipid composition

Future Directions

Expanding this work to include disease state samples will allow us to obtain a spatial understanding of lipid remodeling within CVD. It will also allow us to determine new potential biomarkers of CVD as well as deeper our understanding of how lipids impact CVD disease pathology by comparing the disease state to our healthy lipid profiles.

Acknowledgements

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References

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Figure 1 and Sample Preparation created with BioRender.com