

# INTERVENTIONAL STAFF DOSE REDUCTION: GAINING INSIGHT THROUGH NEW TECHNOLOGY

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MUST DECLARE THAT PHILIPS FUNDED THE KIT –  
BUT NOT ME!



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# Outline of my talk

- Why electronic?
- Introduction to our specific technology
- Early attempts to utilise the data
- Current promising avenues of further research



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# IONISING RADIATION SAFETY COMMITTEE – ORC REPORT, DECEMBER 2017

## COMPLIANCE OF DEPARTMENTS WITH NUH STAFF DOSE MONITORING STANDARDS

Figures below are latest data for compliance with the 2 NUH standards on staff dose monitoring; 80% dosemeters returned within 2 weeks and 90% returned within 1 month. The first number is % returned after 2 weeks, the second figure the % for 1 month. A 'red' colour code indicates breach of at least 1 standard. [NB:- RETURNED DOES NOT EQUATE TO WORN]

Departments with 'red' name are non-compliant at least 50% of time.



2017												
Department	January	February	March	April	May	June	July	August	Sept	Oct	Nov	Dec
MONTHLY												
Cardiology [Interventional]	88/88	84/89	94/?	90/92	87/87	96/?	80/80	86/87	83/100	83/83		
Radiation Physics	100/100	100/100	82/?	100/100	88/88	88/?	94/100	100/100	94/94	94/94		
Medical Physics Trainees	50/75	50/75	100/100	50/100	80/80	100/100	100/100	80/80	80/100	40/60		
Nuclear Medicine [City]	3/93	93/93	84/?	0/99	88/100	100/100	99/99	85/85	84/91	95/95		
Nuclear Medicine [QMC]	91/100	97/97	89/?	69/69	85/85	85/?	83/83	94/100	100/100	98/100		
Nuclear Medicine [SIRT]	0/96	64/64	77/?	0/0	N/A	N/A	100/100	100/100	100/100	100/100		
Radiology [Specialist Registrars]	79/84	82/88	71/?	89/89	74/75	67/?	67/78	74/81	77/88	65/73		
Radiology [City Interventional]	83/91	90/91	95/?	97/97	93/93	100/100	82/87	88/91	78/85	86/92		
Radiology [QMC Interventional]	96/96	91/91	96/?	97/97	87/90	87/?	93/97	88/93	91/92	93/94		
Radiotherapy Physics	100/100	100/100	91/?	100/100	97/100	97/?	97/97	100/100	94/100	94/97		
Radiotherapy Wards - FRASER	100/100	100/100	100/100	?	N/A	N/A	N/A	N/A	N/A	N/A		

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# Why electronic dosimeters?

- Don't require changing every month [see last slide!]
- Real time
- Open up additional 'big brother' possibilities! (see later)

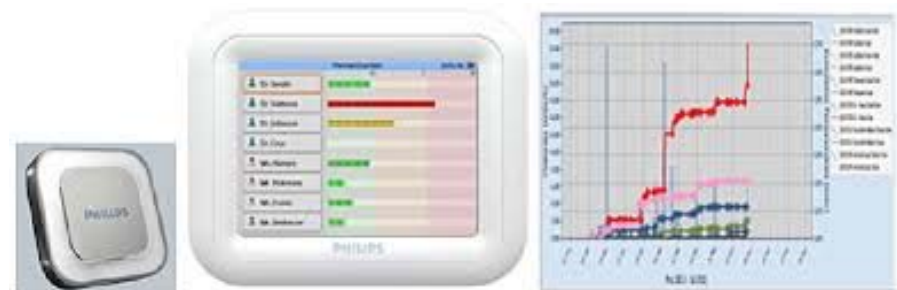


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# Introduction to the specific technology



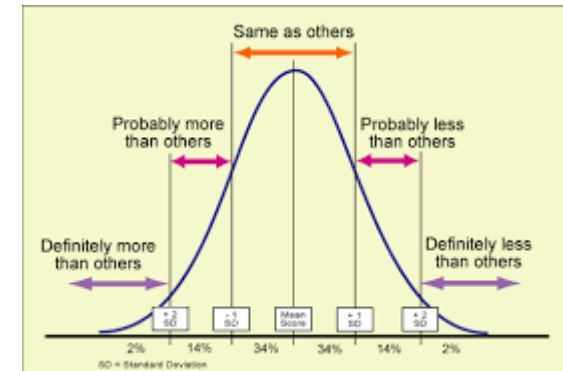
- Utilising the RaySafe i2 dosimeter
- Integrated into Philips Alura/Azurion – time issue
- Philips DoseAware Xtend – enables wifi hubs to capture dose data over network
- Integrated with Philips DoseWise
- Get Staff + Patient RDSR
- Event-level data
- Reference dose



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# Issues with the technology

- Not all dosimeters born equal! – The variance issue
- Range of wi-fi
  - We have named dosimeters
  - They broadcast from outside the room!
  - Consultants have a cupboard outside room for their Pb's
  - They all come up on the screen!



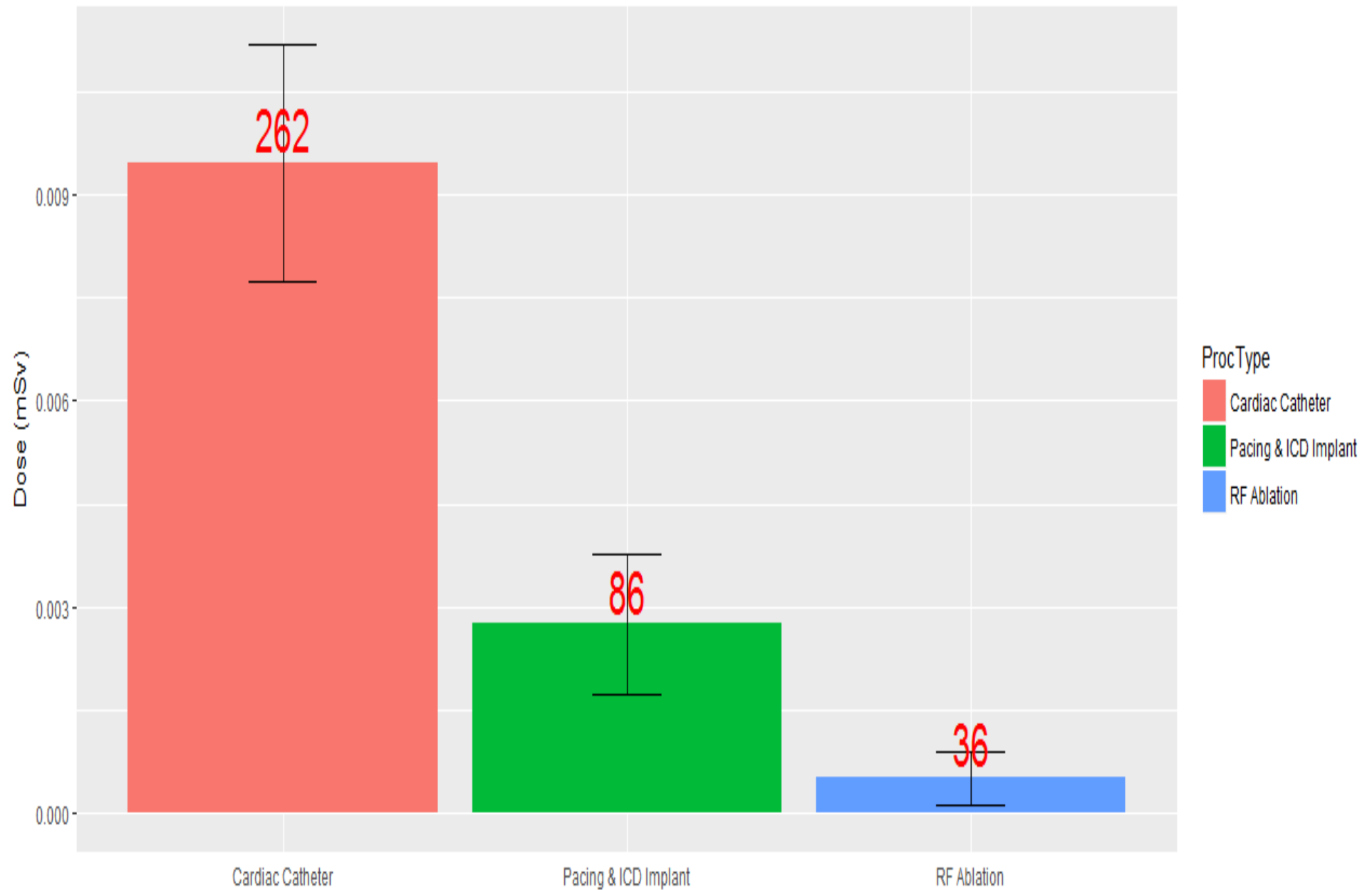
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# Early data playing



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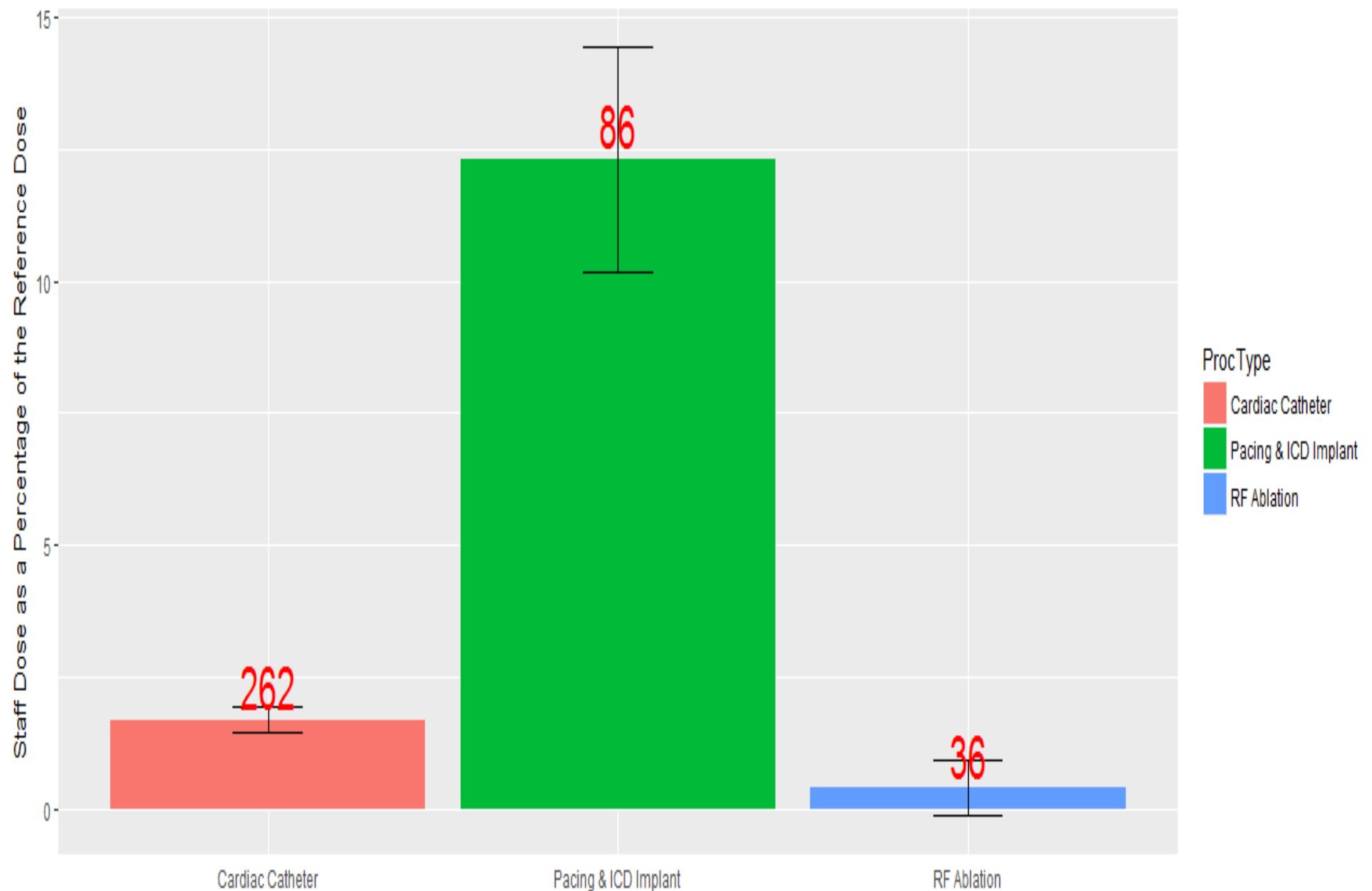
## Median Dose to the Main Operator in the Main Procedure Types





# Median Dose to the Main Operator as a Percentage of the Reference Dose in the Main Procedure Types

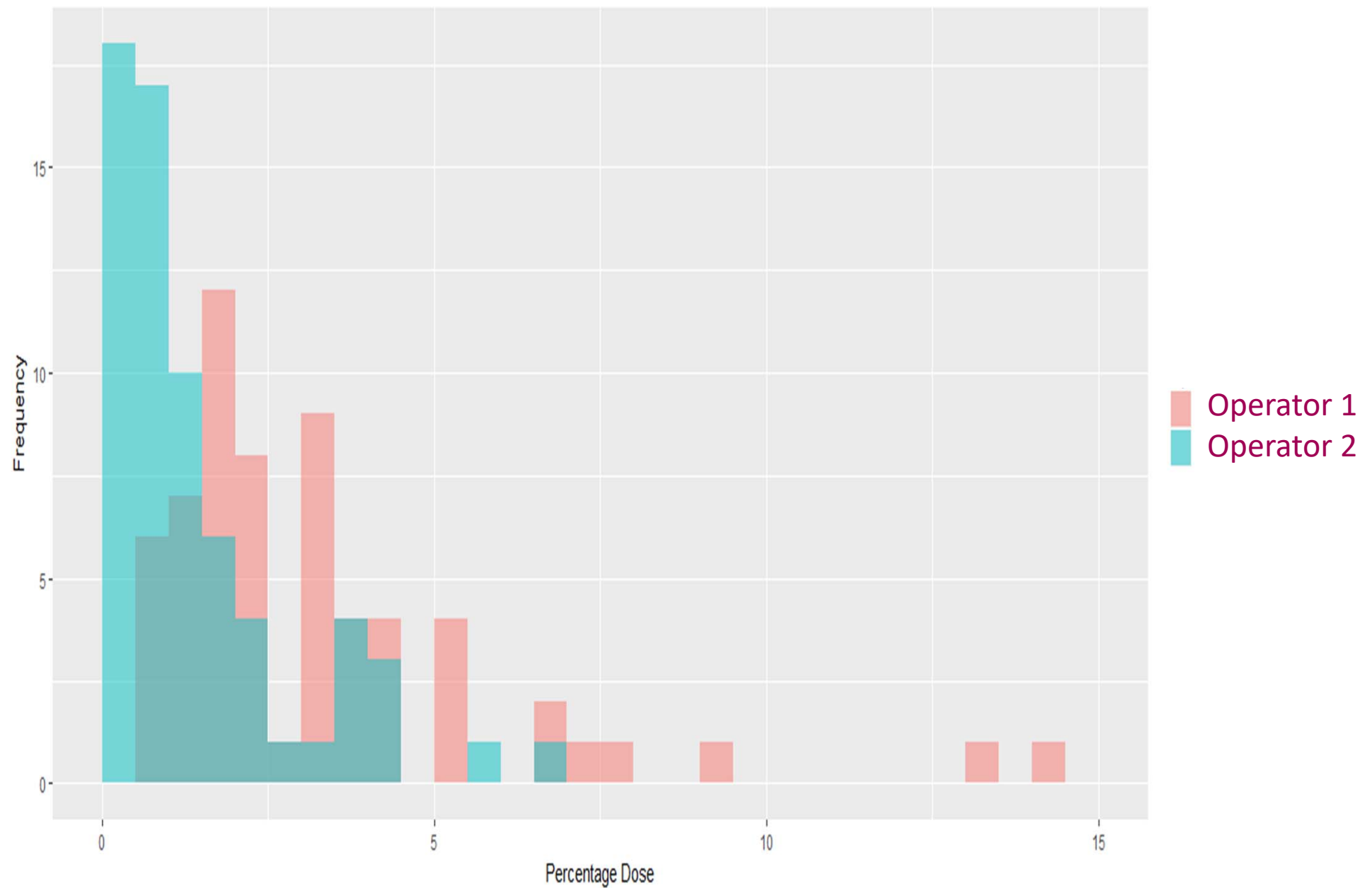
NHS Trust



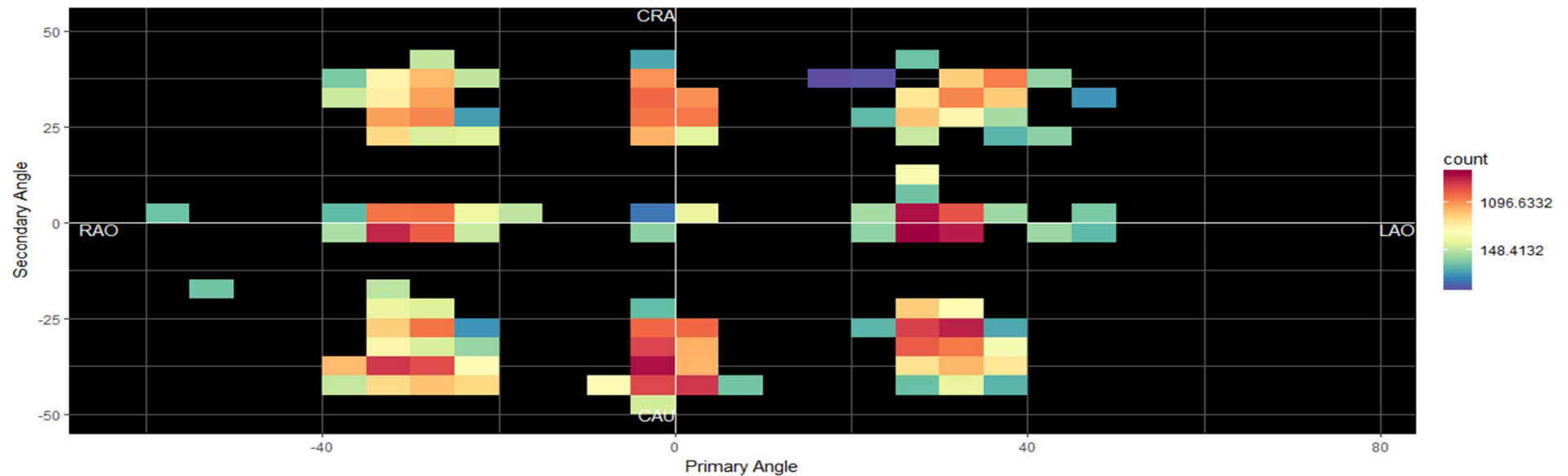
# Median Dose to the Main Operator by Operator 1 for Pacing & ICD Implant Procedures



Histogram Showing the Staff Dose as a Percentage of the Reference Doses Received by Two Operators in Cardiac Catheter Procedures



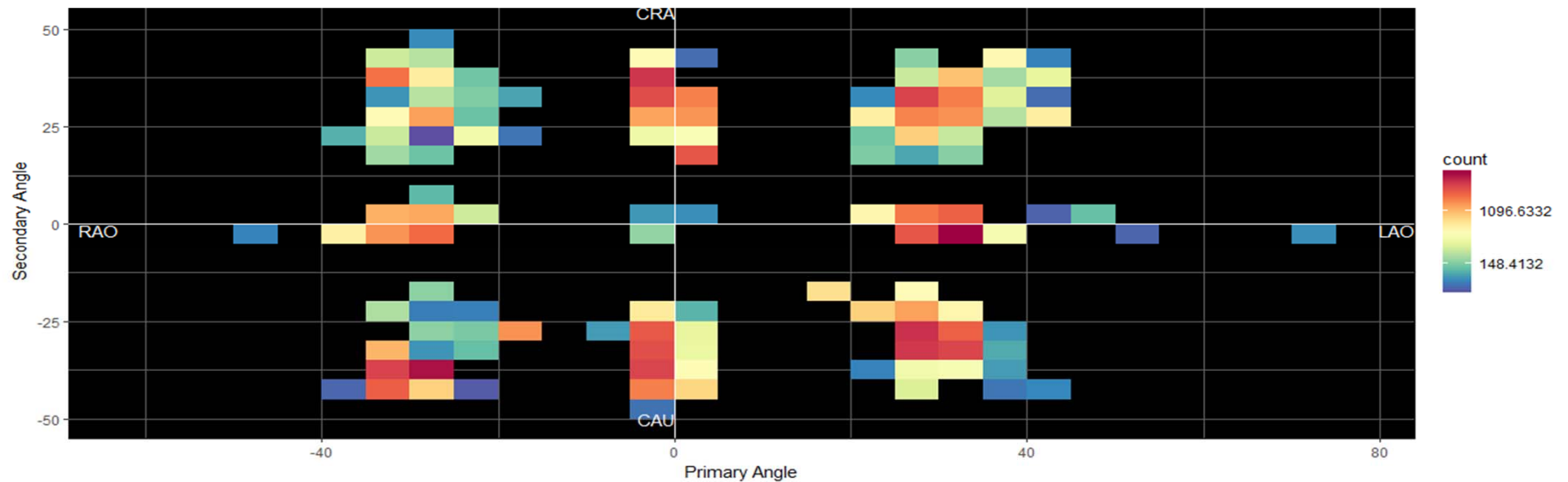
## Heat map of Number of Acquisition Frames for Cardiac Catheter Procedures by Operator 1



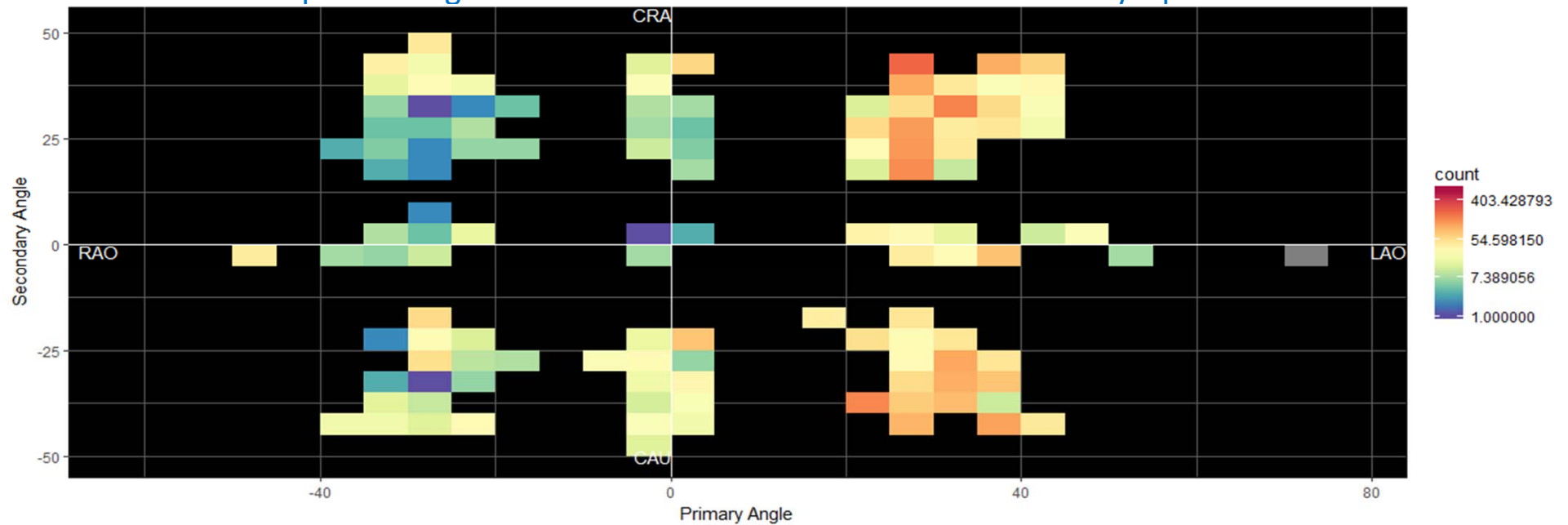
## Heat map of Average Staff Dose for Cardiac Catheter Procedures by Operator 1



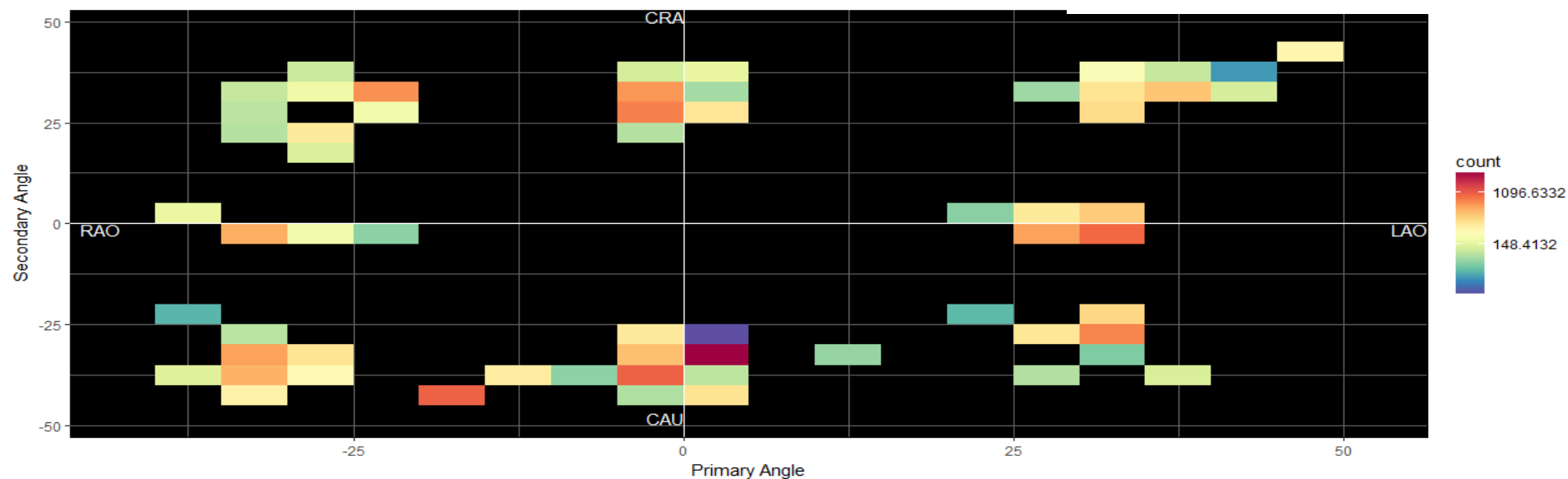
Heat map of Number of Acquisition Frames for Cardiac Catheter Procedures by Operator 2



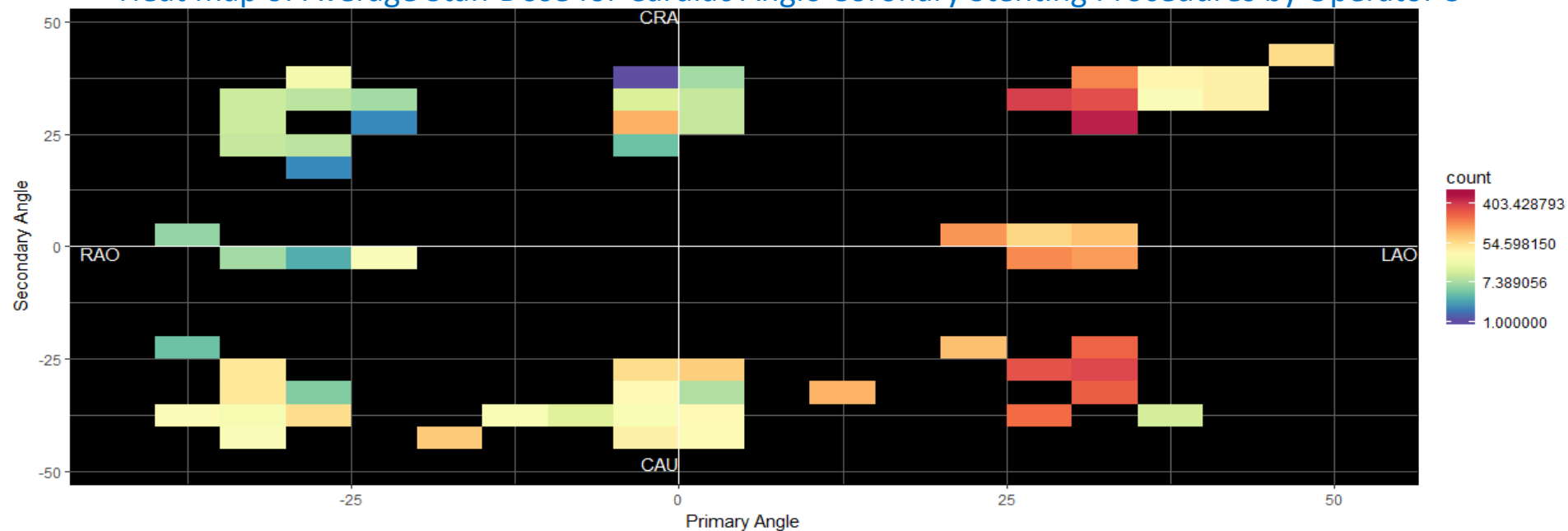
Heat map of Average Staff Dose for Cardiac Catheter Procedures by Operator 2



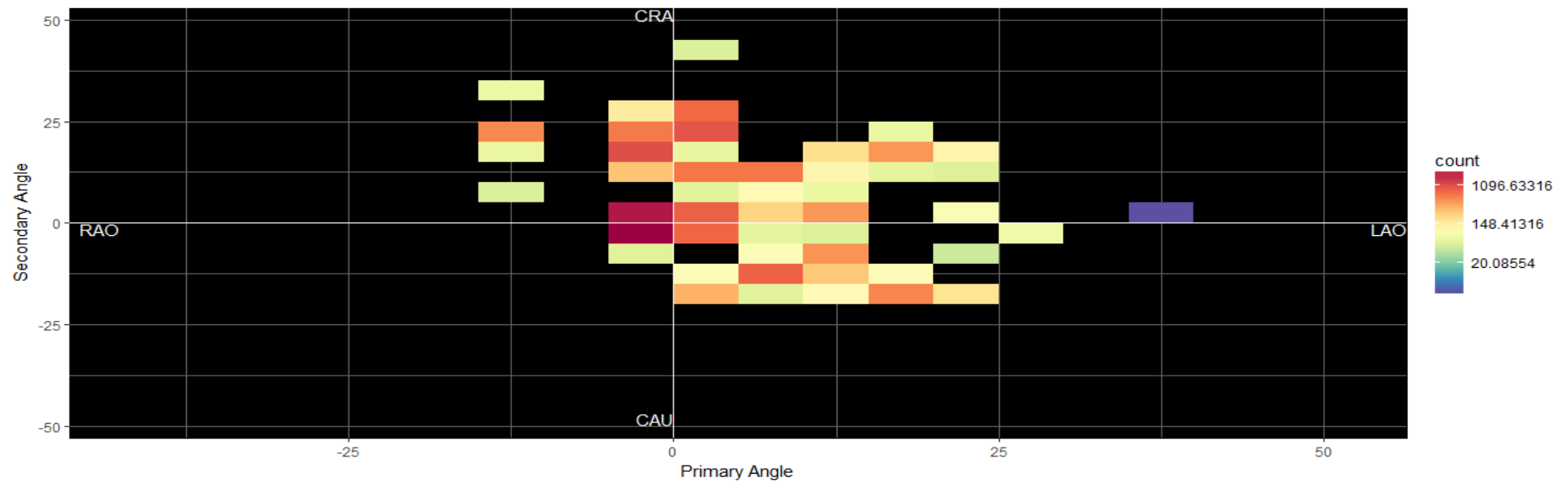
# Heat map of Number of Acquisition Frames for Cardiac Anglo Coronary Stenting Procedures by Operator 3



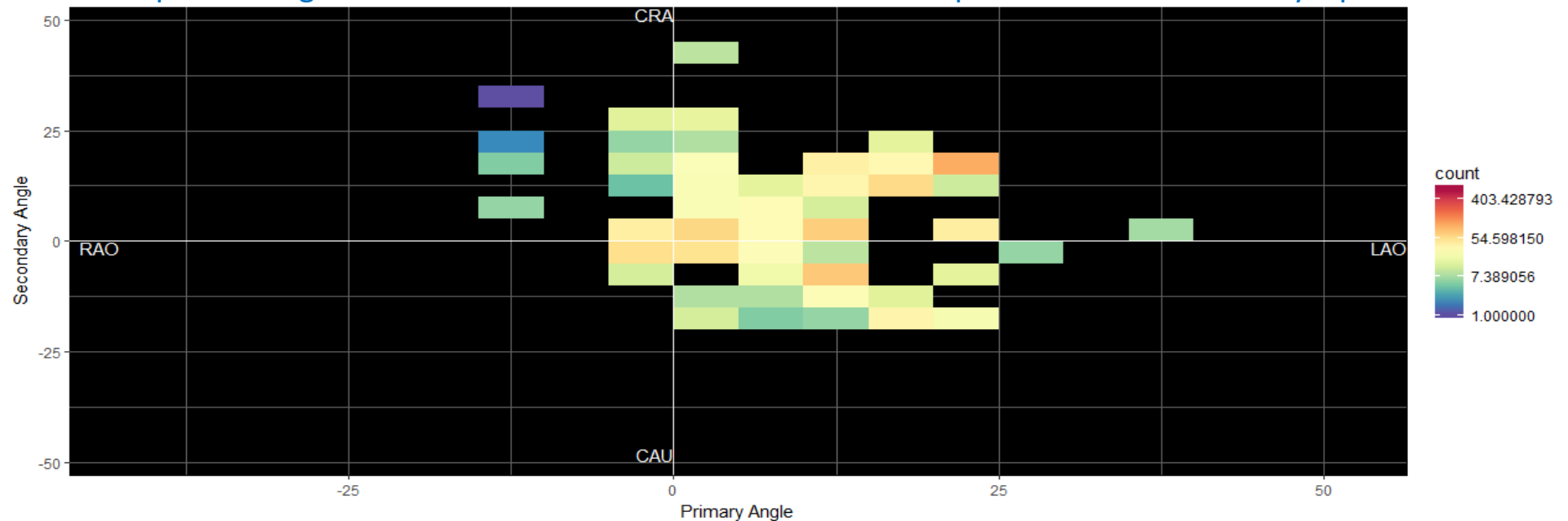
# Heat map of Average Staff Dose for Cardiac Anglo Coronary Stenting Procedures by Operator 3



## Heat map of Number of Acquisition Frames for Transcatheter Aortic Valve Implantation Procedures by Operator 3



## Heat map of Average Staff Dose for Transcatheter Aortic Valve Implantation Procedures by Operator 3



# What next?

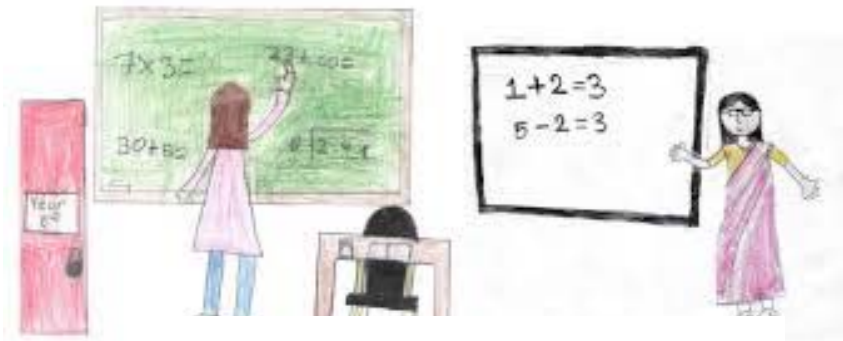


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# Initial conclusions

- Staff feedback of their doses has raised interest
- Software auto reports not good enough
- Need time to input to implement/interpret – more input from MedicalPhysics
- Could we correlate passive/active?  
This was initial project objective



Margin-based MPE

$$f_{\Lambda, \sigma}^{MPE} = \sum_r \frac{\sum_n \varepsilon_{n,r} P(S_n)^{\sigma} P_{\Lambda}(X_r | S_n)^{\sigma} e^{\sigma \varepsilon_{n,r}}}{\sum_k P(S_k)^{\sigma} P_{\Lambda}(X_r | S_k)^{\sigma} e^{\sigma \varepsilon_{k,r}}}$$

Rewrite the cost function in terms of pair-wise comparisons

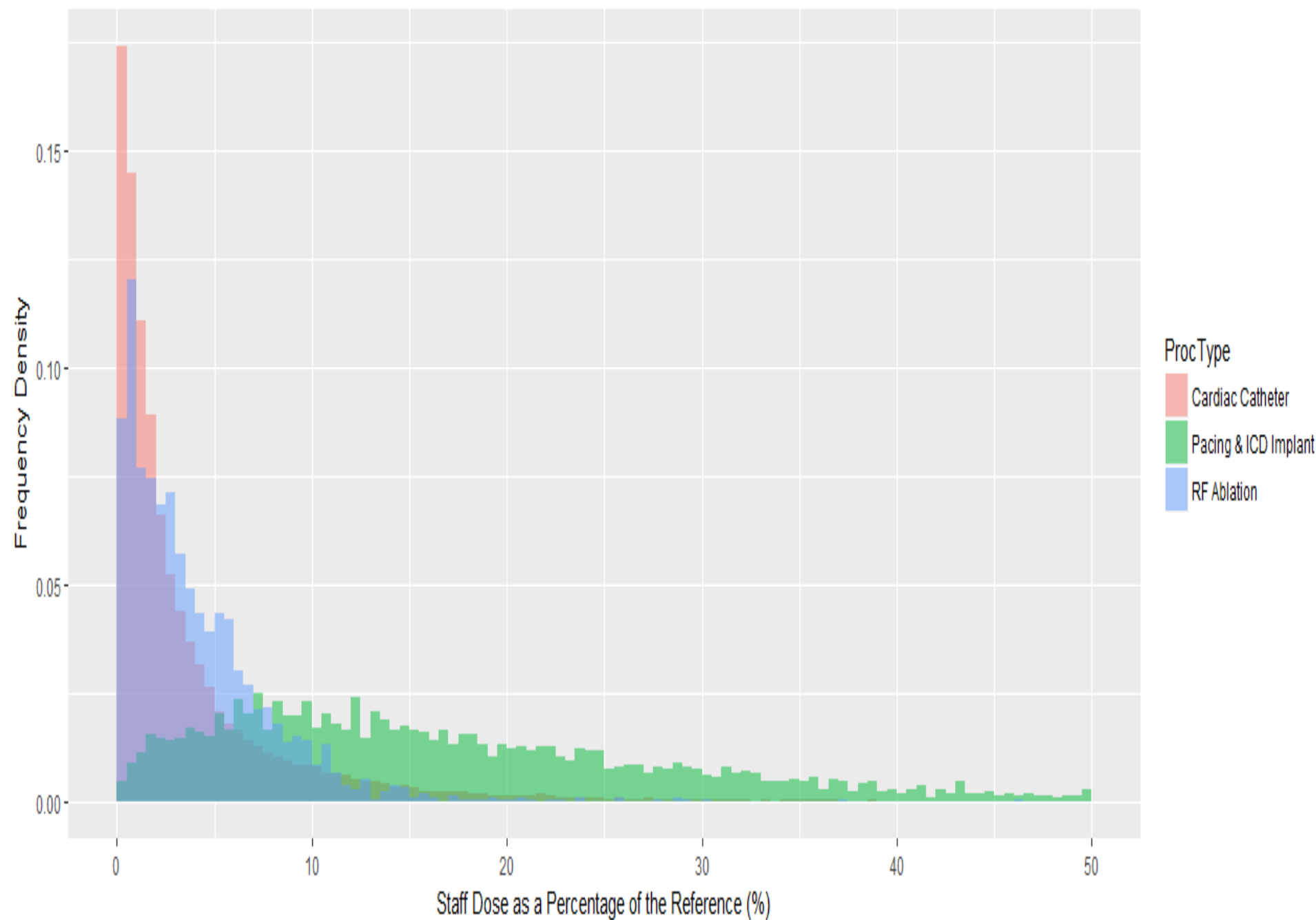
$$m_{k,n}(X_r, \Lambda) = \log(P(S_k) P_{\Lambda}(X_r | S_k)) - \log(P(S_n) P_{\Lambda}(X_r | S_n))$$

Then the modified MPE loss can be expressed as

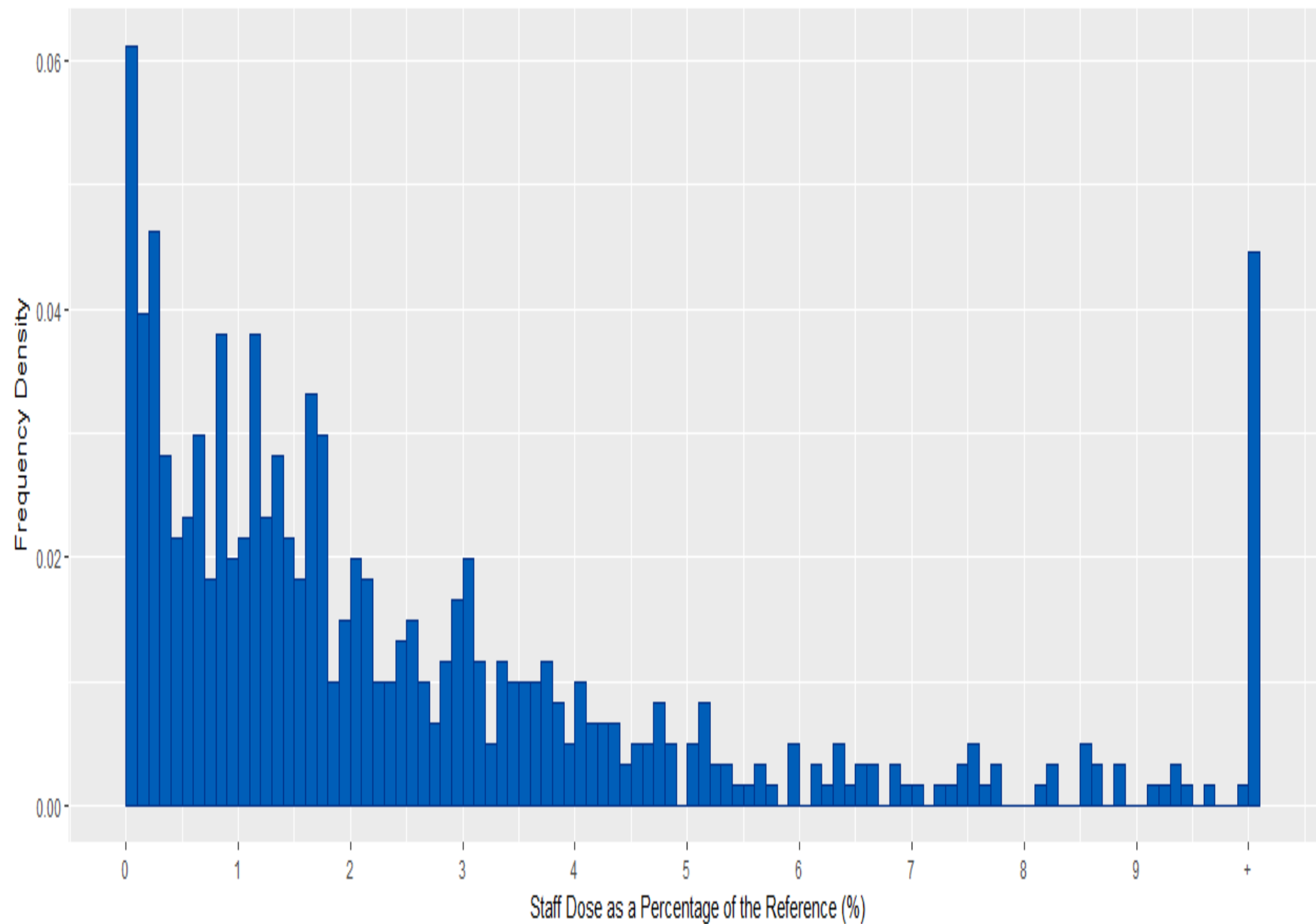
$$f_{\Lambda, \sigma}^{MPE} = \sum_r \sum_n \frac{\varepsilon_{n,r}}{1 + \sum_{k \neq n} e^{(\sigma m_{k,n}(X_r, \Lambda) - \sigma \varepsilon_{n,r})}}$$

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Histogram of the Staff Dose as a Percentage of the Reference Dose by the Main Procedure Types



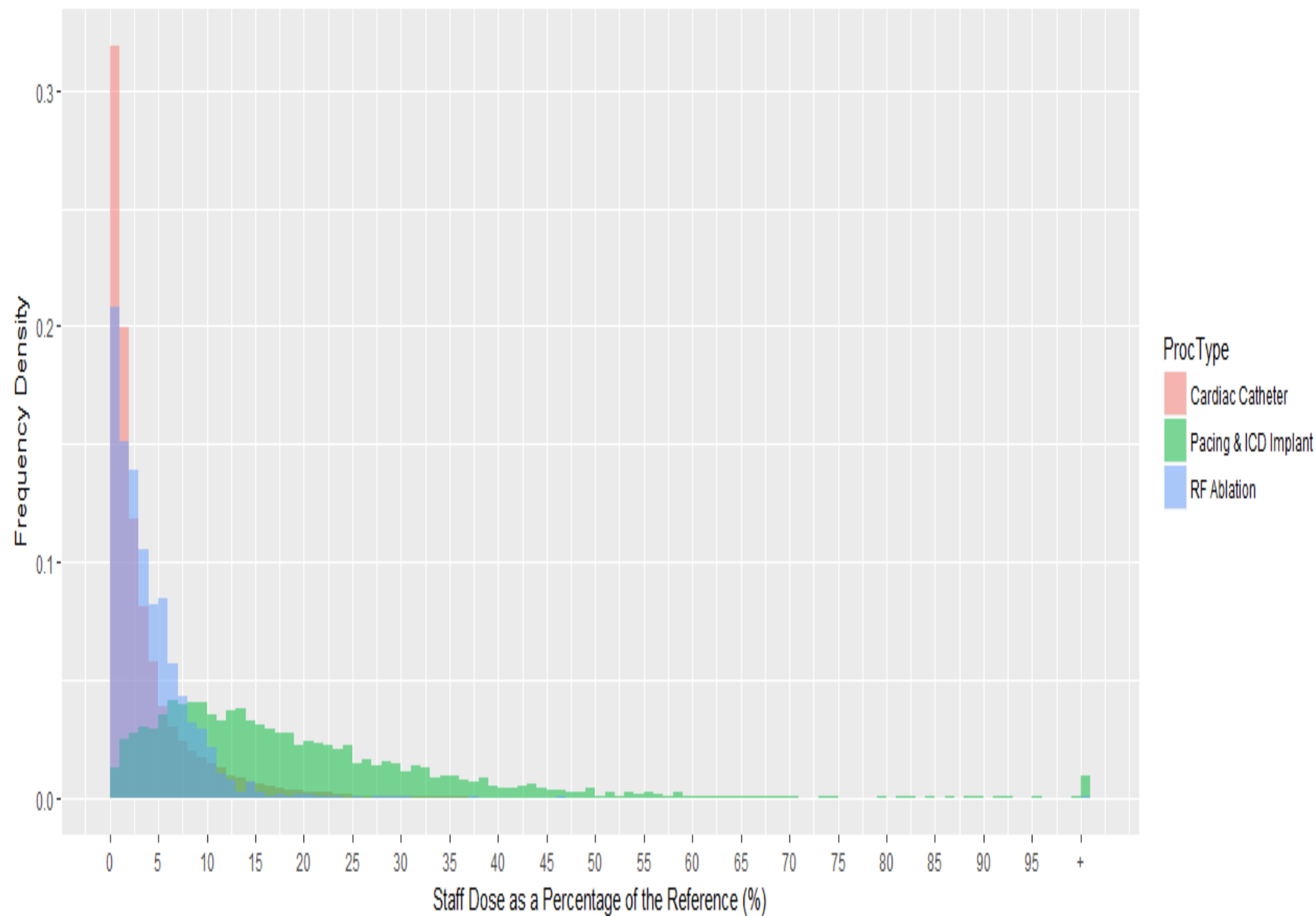
Histogram of the Staff Dose as a Percentage of the Reference Dose for Cardiac Catheterisation and RF Ablation Procedures



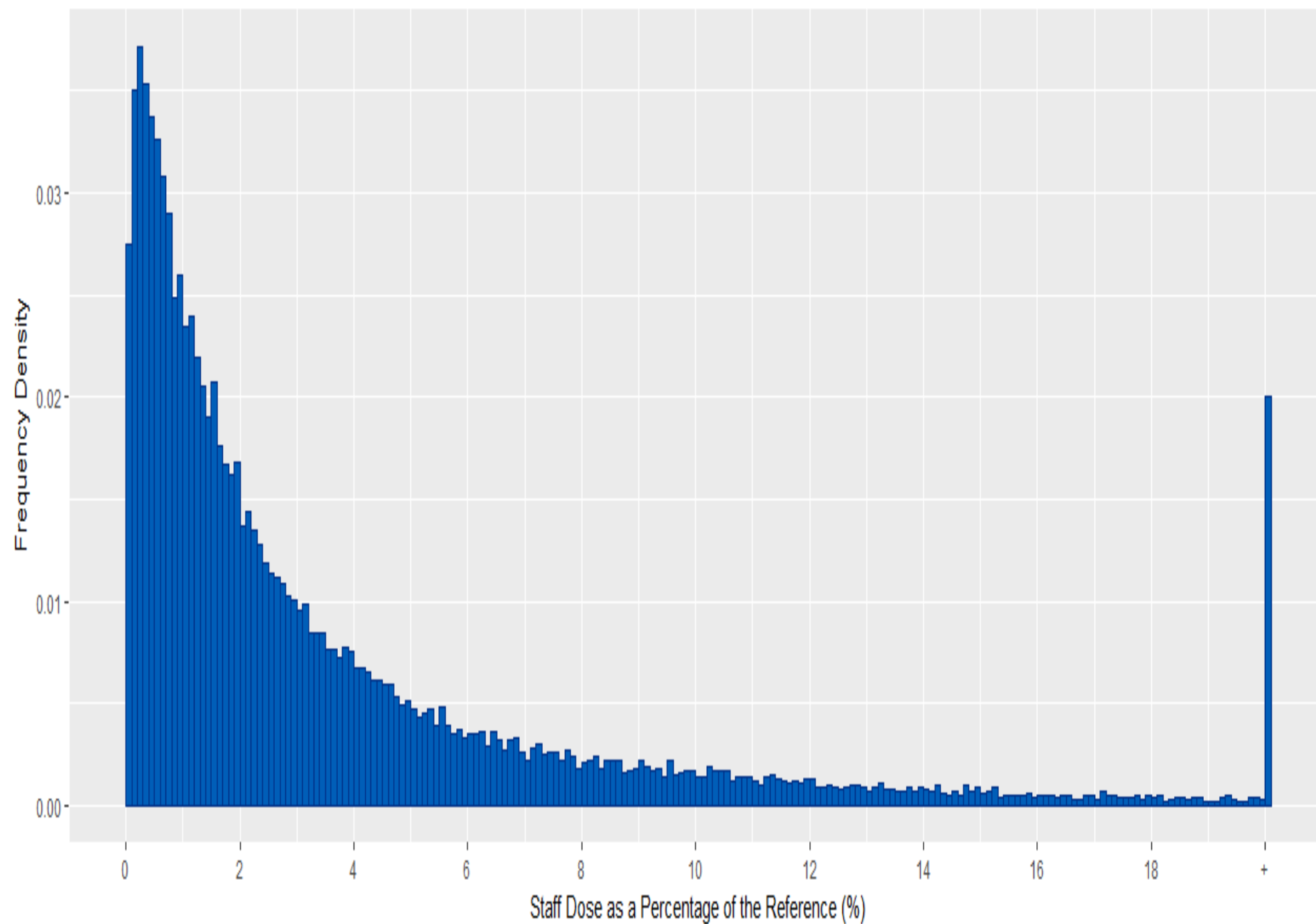
# Event

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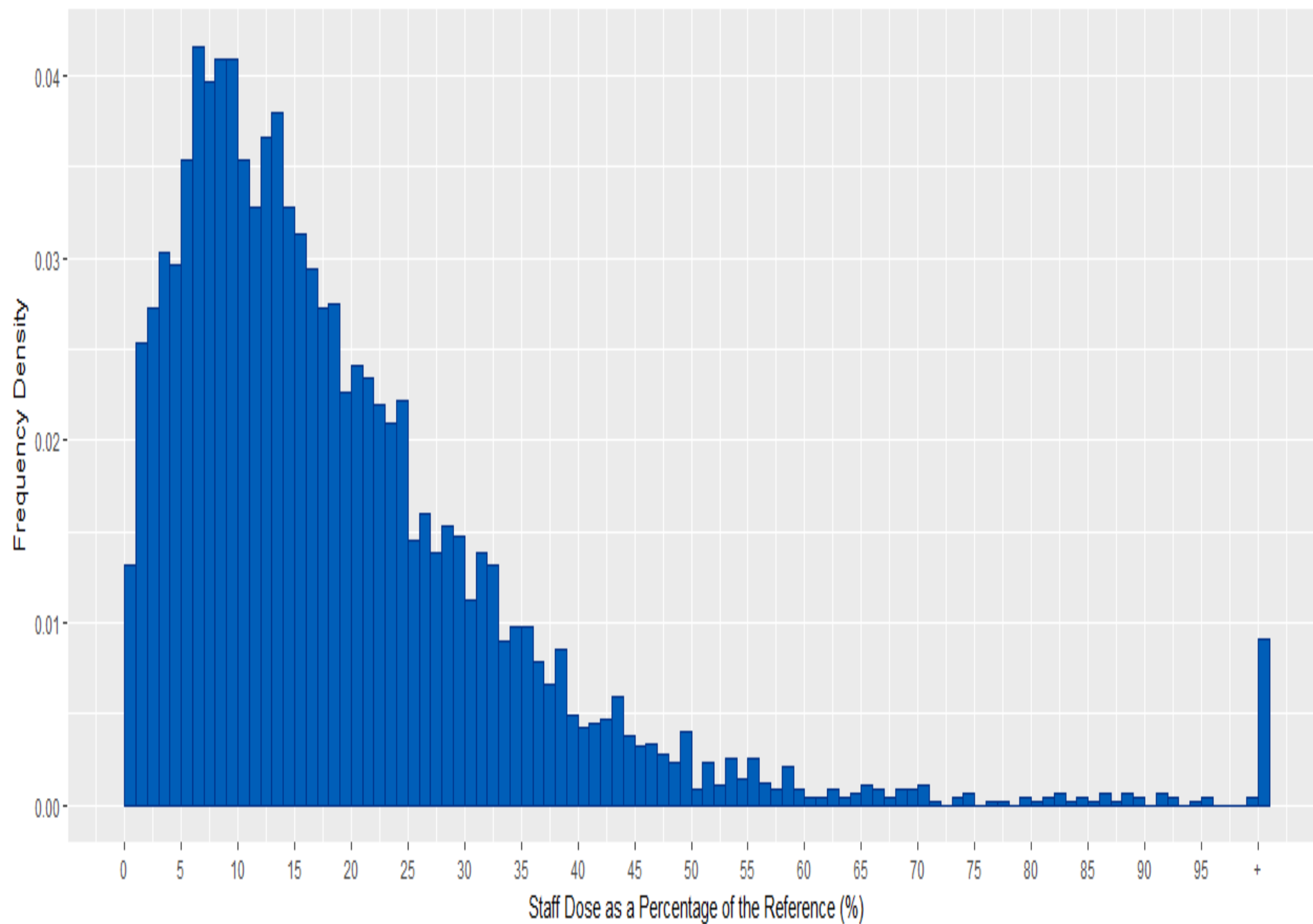
Histogram of the Staff Dose as a Percentage of the Reference Dose by the Main Procedure Types

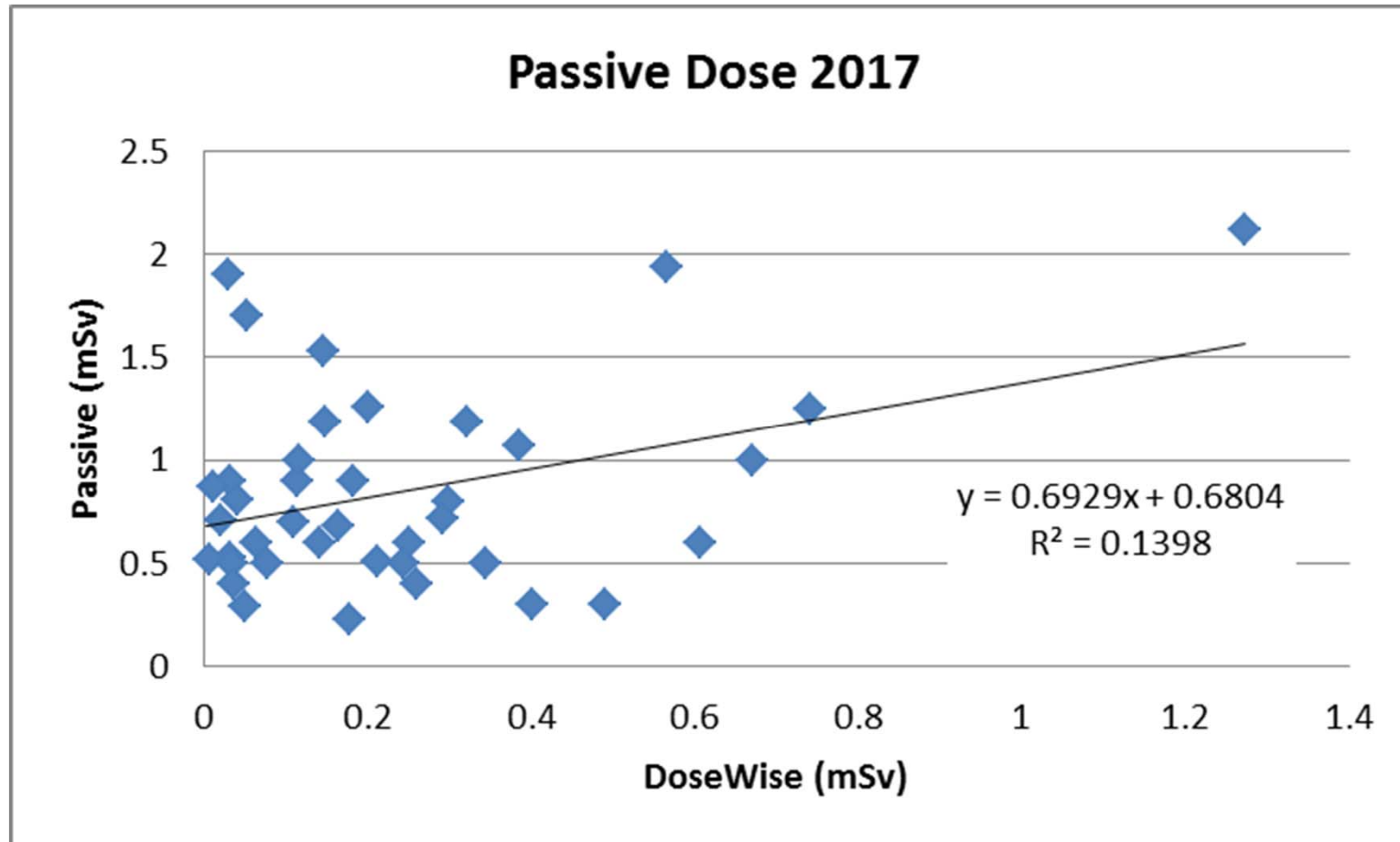


Histogram of the Staff Dose as a Percentage of the Reference Dose for Cardiac Catheterisation and RF Ablation Procedures



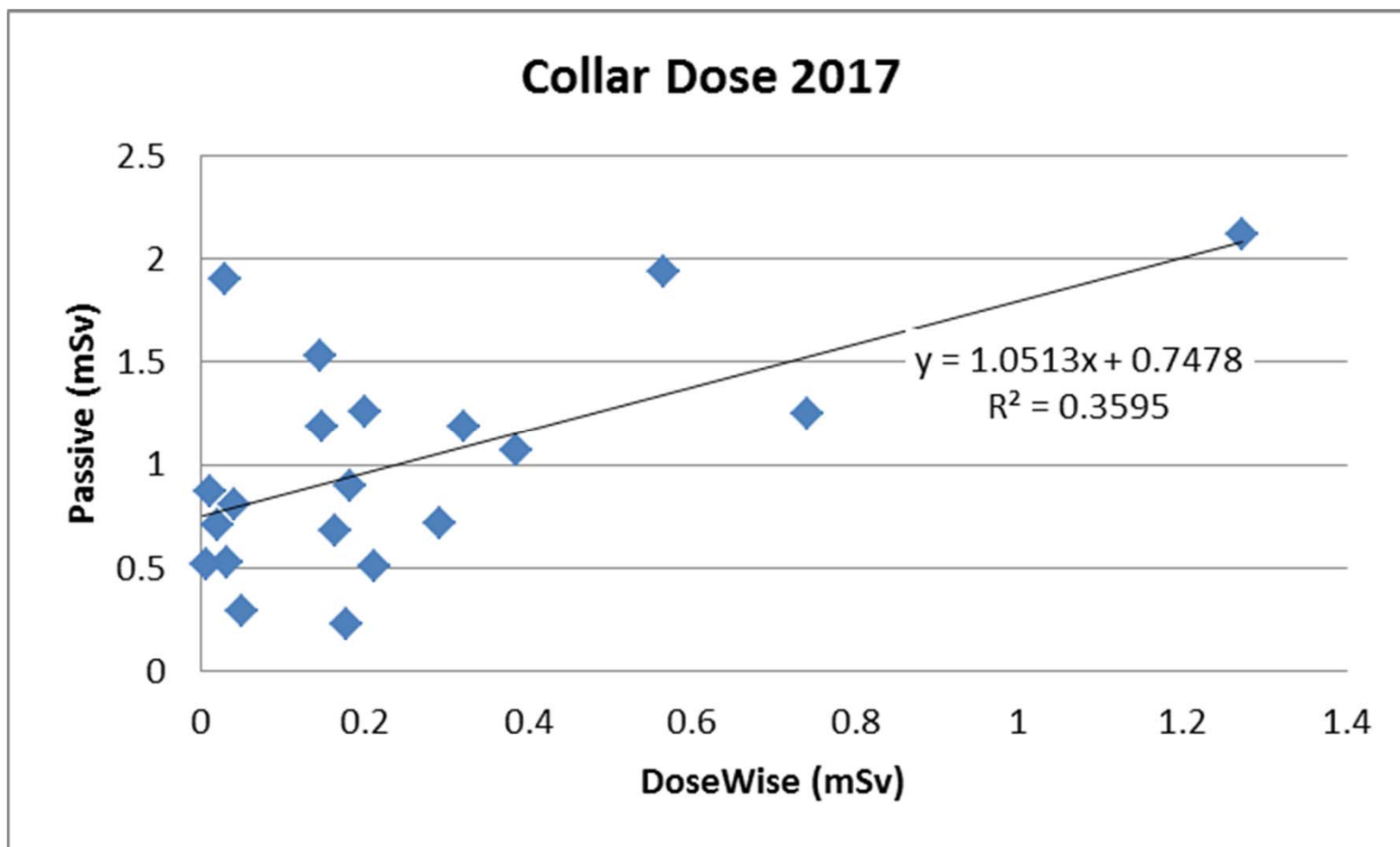
Histogram of the Staff Dose as a Percentage of the Reference Dose for Pacing & ICD Implant Procedures





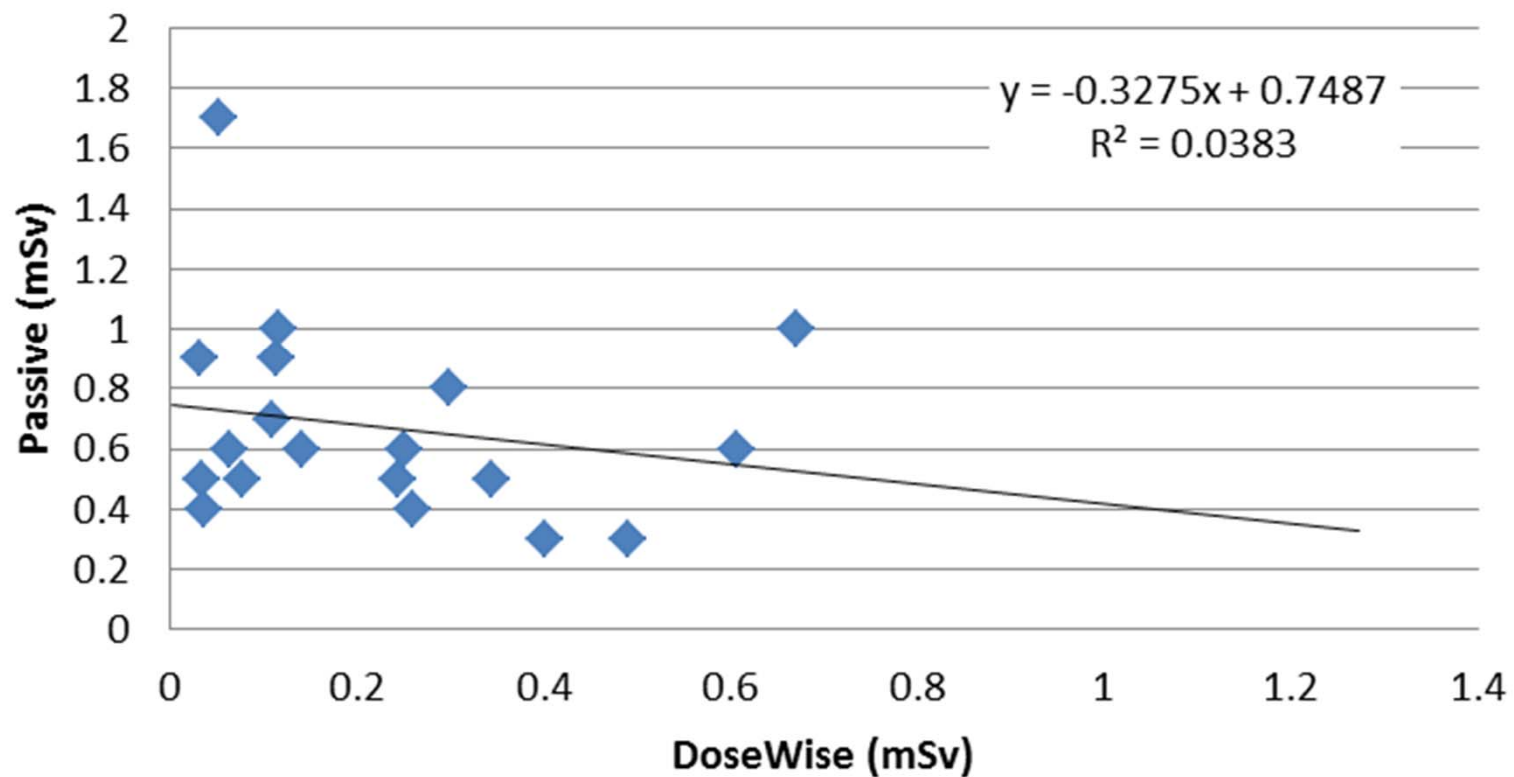
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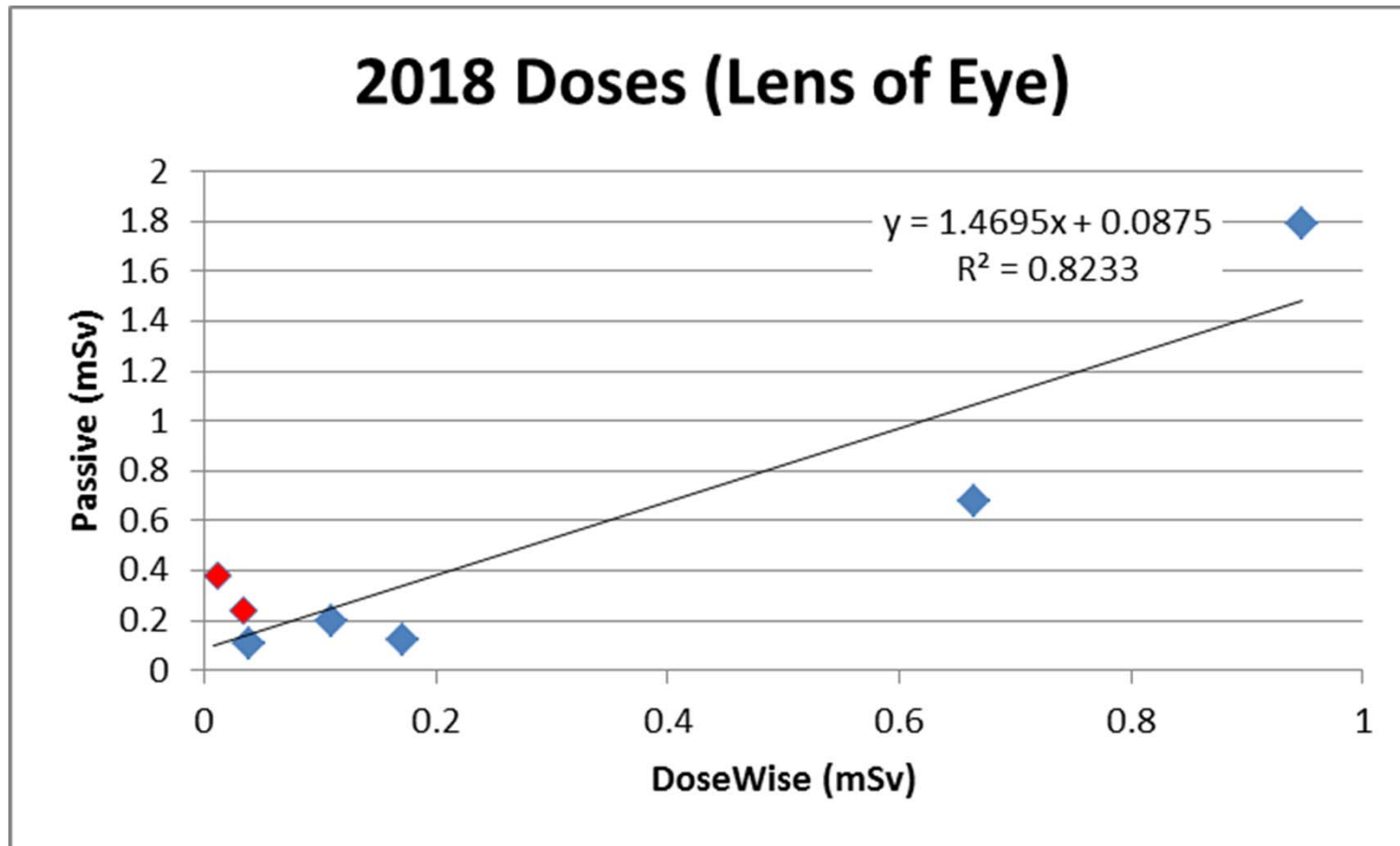
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## Lens of Eye Dose 2017



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**RED = RHS Table Work** (Omitting doesn't change correlation much)



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# Further Work

- Use dose & reference dose data to feedback to trainee cardiologists
- Investigate heat maps as training aid for trainees
- Hopefully correlate passive & active for collar/eye
- ?eliminate passive apart from finger rings

Thank you!

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