Optimisation of CT Scan Planar Radiographs

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Introduction

- Scan Planar Radiographs (SPRs)
  - Used for patient positioning
  - Allows mA modulation of the CT helical scan

- Manufacturer specific terms
  - Surview (Philips)
  - Scanogram (Toshiba)
  - Topogram (Siemens)
  - Scout (GE)
  - Will refer to SPRs throughout

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Introduction

- Foundation year training project
- Previous research had shown that SPR may account for as much of 19% of CT dose*
- As CT doses come down in the future SPR dose likely to have greater contribution

* A Comparison of Effective Dose Calculations for CT SPRs using DAP Conversions and MOSFET Organ Doses, J. Cheesewright. MSc University of Glasgow, 2015.

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Introduction

- Default SPR views and exposure factors vary significantly between manufacturers and scanners
  - ➢PA, AP, lateral or dual SPRs
- Defaults are used as standard

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Aim

- Assess the possibility of lowering SPR doses without impacting CT image acquisition
- Investigate the effect of reducing SPR mA on CT mA modulation
- With the assumption that if the CT mA modulation is unaffected then the CT image quality will also not change

Method

- 4 CT scanners investigated

System	Default SPR Views	Default SPR Factors
Phillips Brilliance Big Bore	PA	30 mA, 120 kV
Toshiba Aquilion 64	PA Lateral	50 mA, 120 kV 100 mA, 120kV
Siemens Definition AS	AP	35 mA, 120 kV
Siemens Sensation 64	AP	35 mA, 120 kV

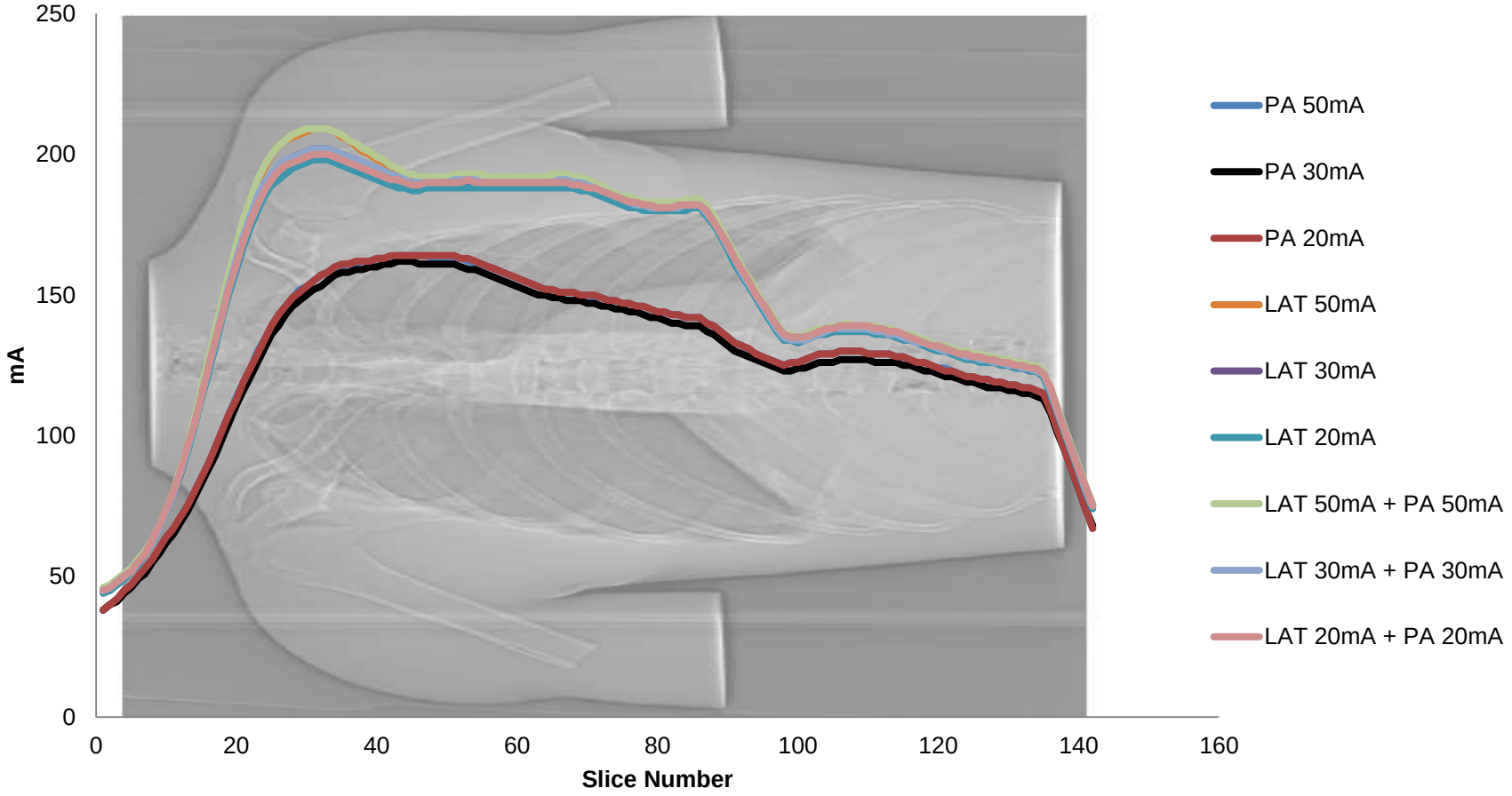
Method

- Anthropomorphic chest phantom scanned using standard clinical chest CT protocol and default SPR parameters
- Additional SPRs acquired
  - mA varied
  - Different views (AP, PA, lateral, dual) chosen based on default and available settings
  - kV kept constant at 120 kV
- For each SPR a CT helical scan was acquired
- ImageJ SpiceCT plugin* used to extract average tube current per CT slice and create mA modulation curves for each CT dataset

* With thanks to John Loveland!

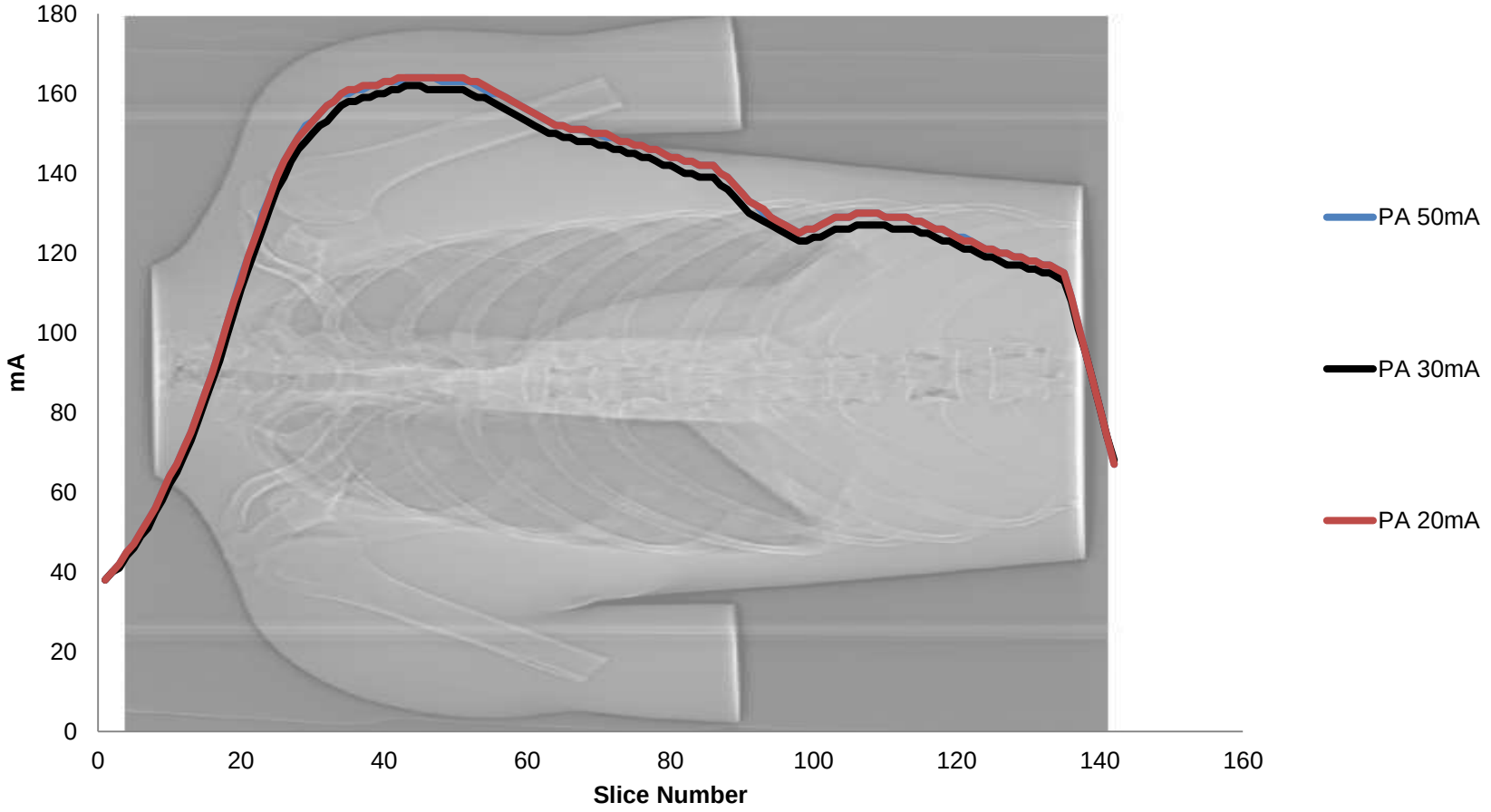
Results –Philips Brilliance Big Bore Scanner

- Default SPR: PA scan at 30 mA



Results –Philips Brilliance Big Bore Scanner

- PA SPRs at 50 mA, 30 mA and 20 mA



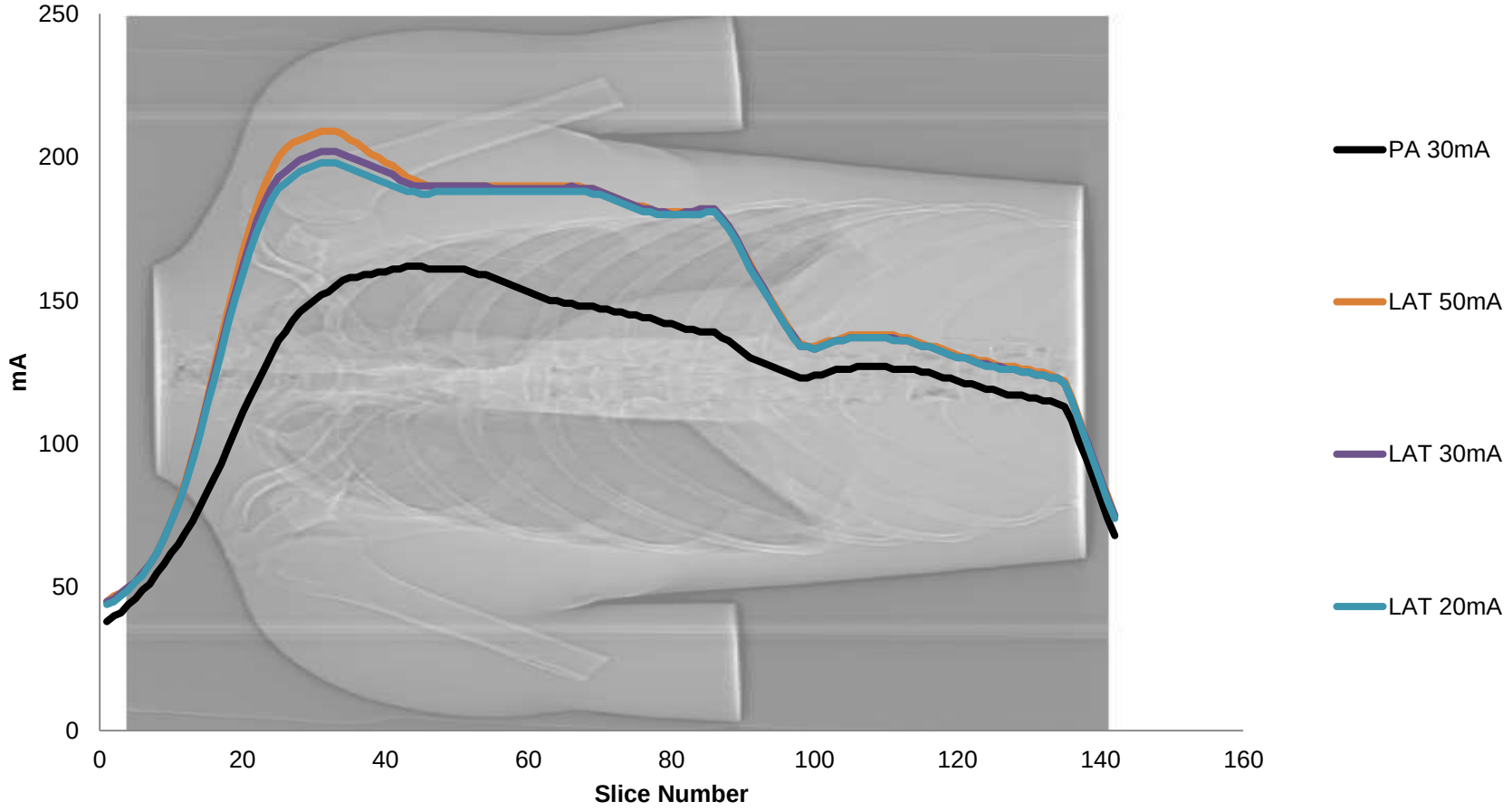
Results –Philips Brilliance Big Bore Scanner

- Very little change in mA modulation for PA SPRs at 50 mA, 30 mA and 20 mA

- $CTDI_{VOL}$ remained constant to within 0.1 mGy

Results –Philips Brilliance Big Bore Scanner

- Lateral SPRs at 50 mA, 30 mA and 20 mA



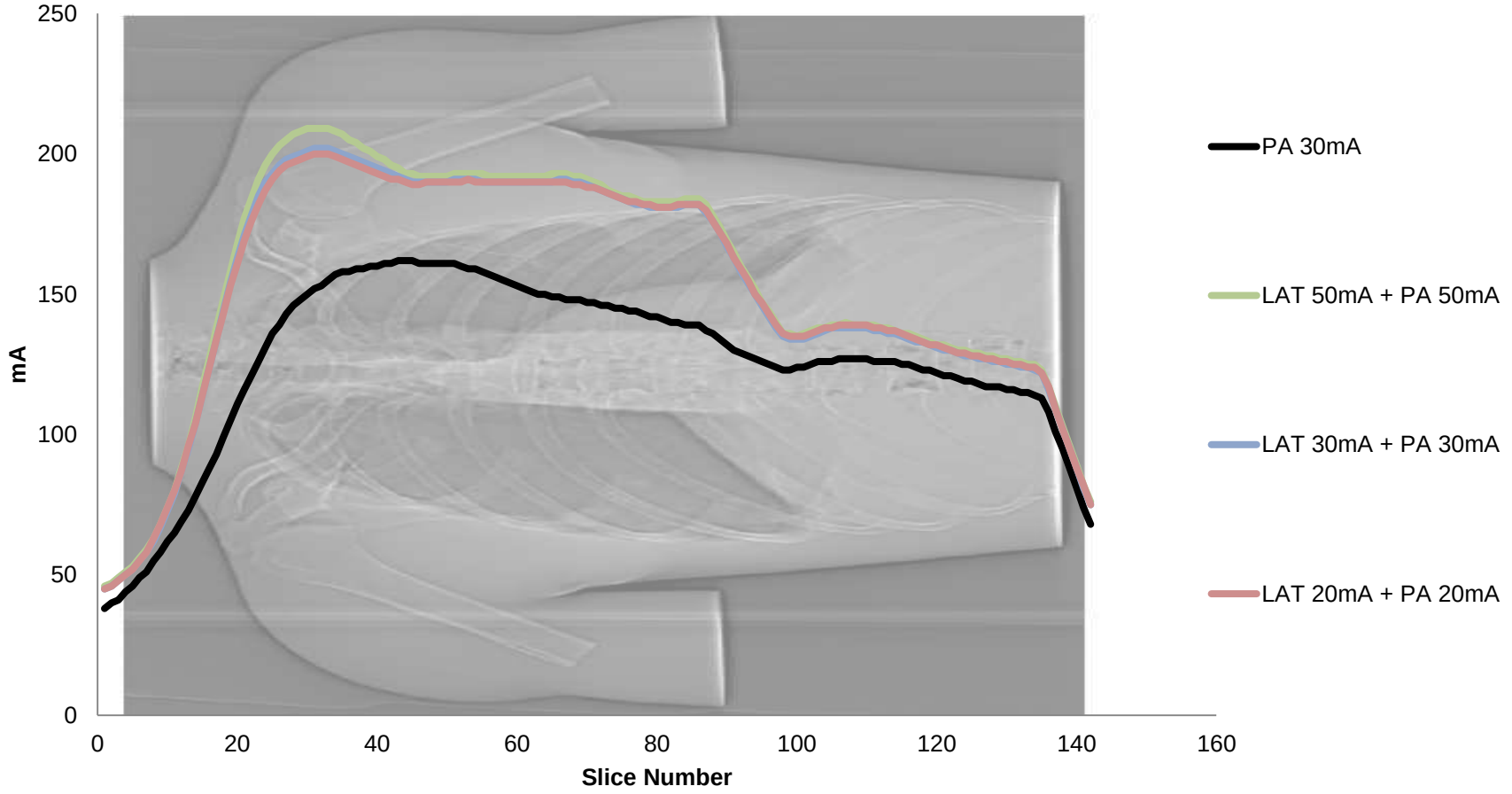
Results –Philips Brilliance Big Bore Scanner

- mA modulation for lateral SPRs at 50 mA, 30 mA and 20 mA very similar
  - $CTDI_{VOL}$ constant for each of these scans

- A lateral SPR gave higher CT mA per slice compared to PA
  - Increase in $CTDI_{VOL}$ from 5.3 mGy to 6.3 mGy
  - Thickness of bone in shoulder and clavicle regions when viewed laterally

Results – Philips Brilliance Big Bore Scanner

- Dual lateral and PA SPRs at 50 mA, 30 mA and 20 mA



Results –Philips Brilliance Big Bore Scanner

- mA modulation for dual SPRs at 50mA/50mA, 30mA/30mA and 20mA/20mA very similar
  - ➢ $CTDI_{VOL}$ constant for each of these scans

- mA modulation and $CTDI_{VOL}$ for dual SPRs very similar to lateral only SPRs

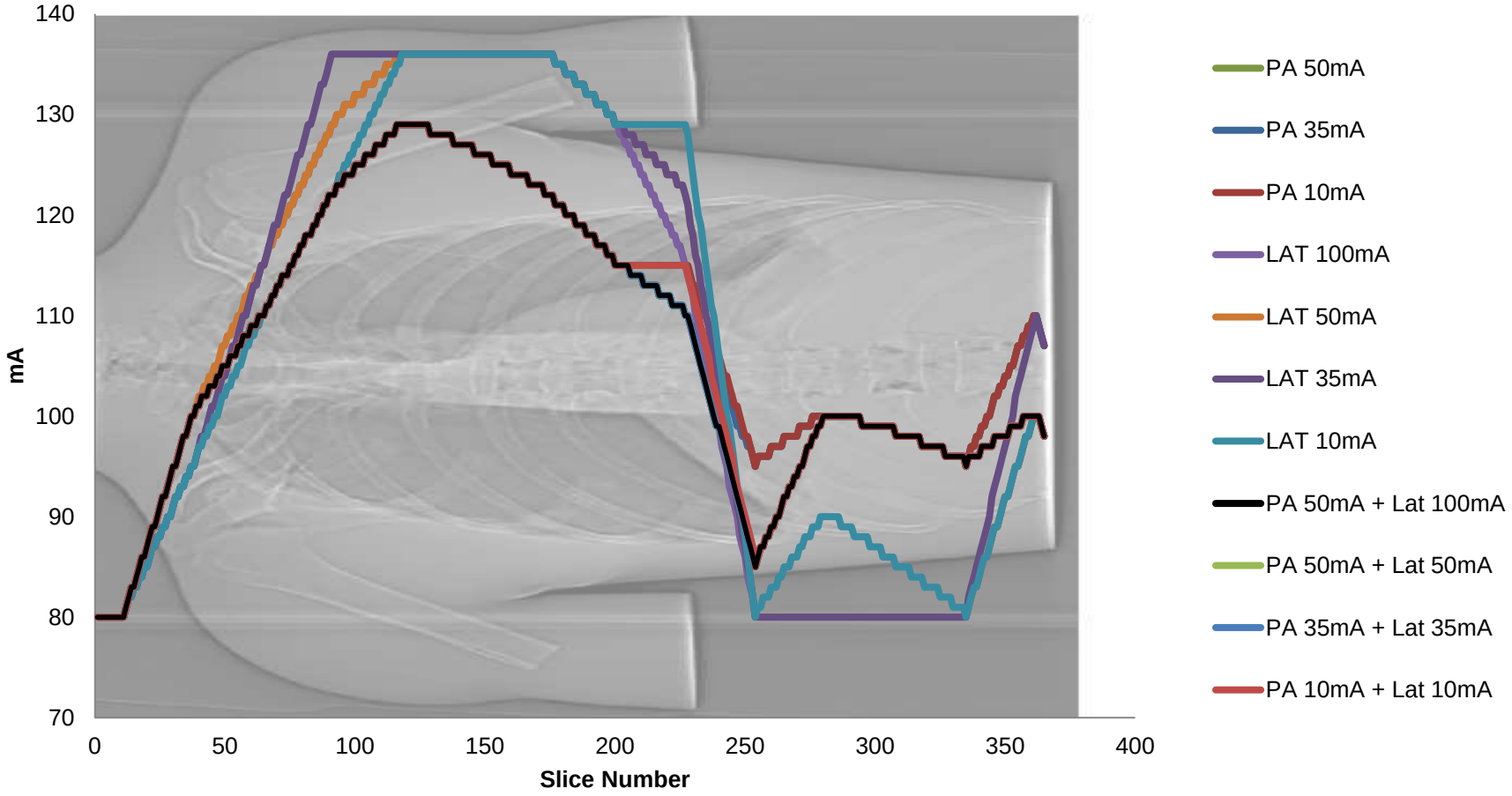
- Dual and lateral only SPRs gave higher CT mA per slice compared to PA

Results – Philips Brilliance Big Bore Scanner

View	mA	$CTDI_{VOL}$ [mGy]
PA	50	5.2
PA	30	5.2
PA	20	5.3
Lateral	50	6.3
Lateral	30	6.3
Lateral	20	6.3
Dual Lateral PA	50 50	6.3
Dual Lateral PA	30 30	6.3
Dual Lateral PA	20 20	6.4

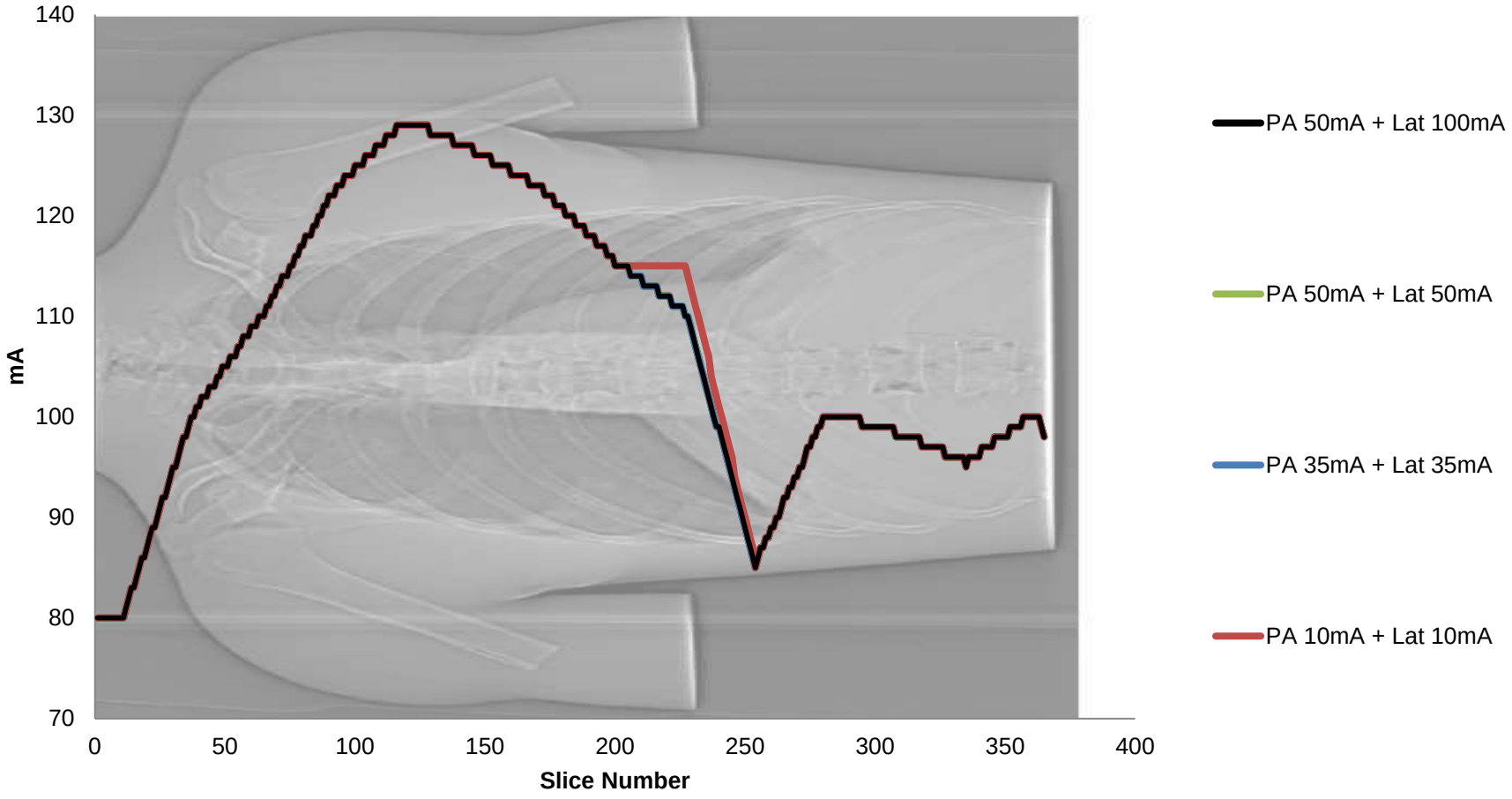
Results – Toshiba Aquilion 64 Scanner

- Default SPR: dual PA SPR at 50 mA and lateral SPR at 100 mA



Results – Toshiba Aquilion 64 Scanner

- Dual SPRs at 50mA/100mA, 50mA/50mA, 35mA/35mA and 10mA/10mA

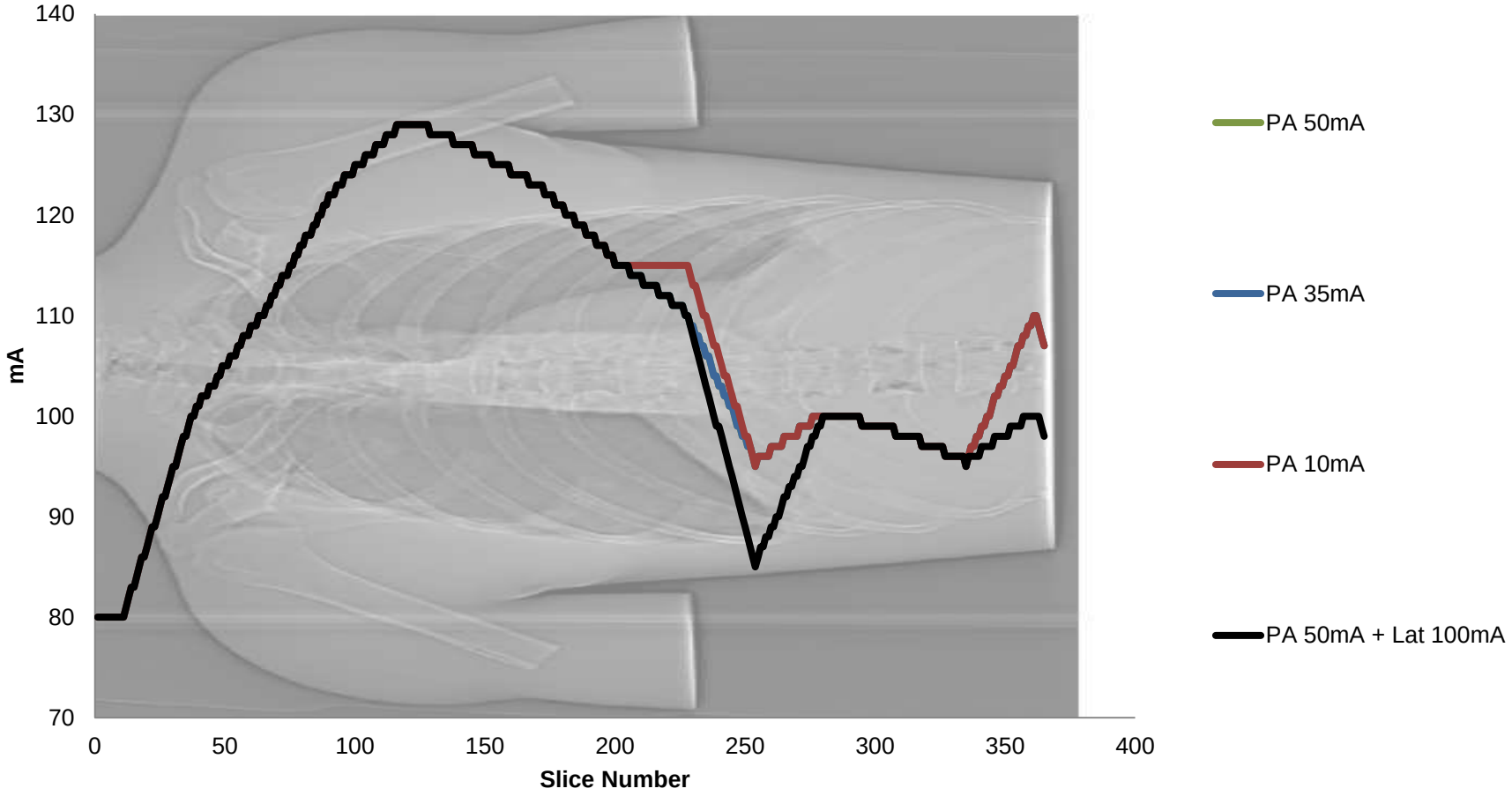


Results – Toshiba Aquilion 64 Scanner

- For dual SPRs reducing SPR mA from 100mA/50mA to 10mA/10mA had little effect on CT mA modulation
  - Complete overlap for 100mA/50mA, 50mA/50mA and 35mA/35mA
  - Some differences seen at 10mA/10mA
  - Constant $CTDI_{VOL}$ of 5.6 mGy for these SPRs

Results – Toshiba Aquilion 64 Scanner

- PA SPRs at 50 mA, 35 mA and 10 mA



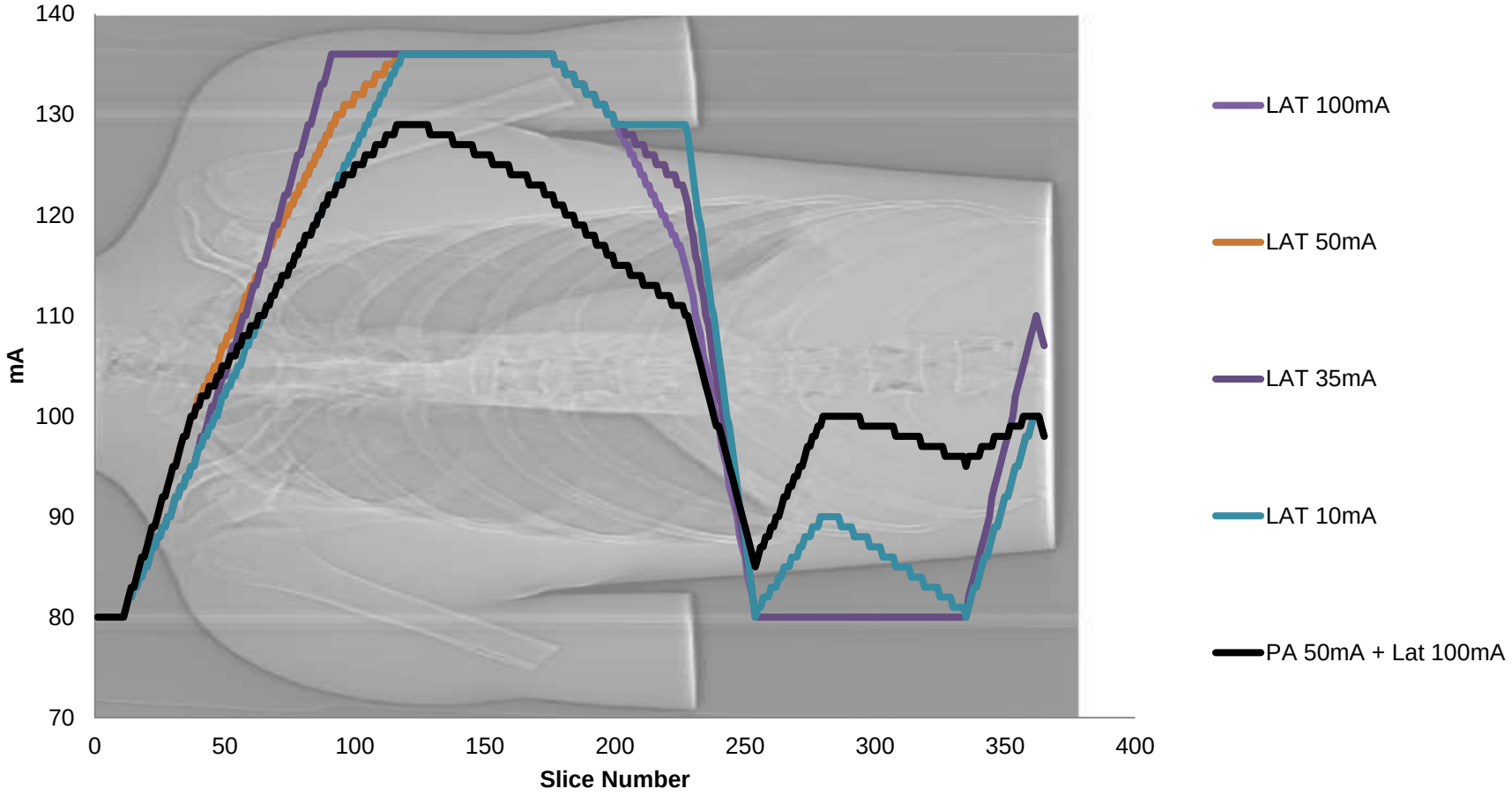
Results – Toshiba Aquilion 64 Scanner

- mA modulation for PA SPRs at 50 mA, 35 mA and 10 mA very similar
  - CTDIVOL consistent to within 0.1 mGy

- Modulation very similar to that obtained with default dual SPR

Results – Toshiba Aquilion 64 Scanner

- Lateral SPRs at 100 mA, 50mA, 35 mA and 10 mA



Results – Toshiba Aquilion 64 Scanner

- More variation seen for lateral SPRs at 100 mA, 50 mA, 35 mA and 10 mA
  - More variation in CT mA modulation than with PA or dual SPRs

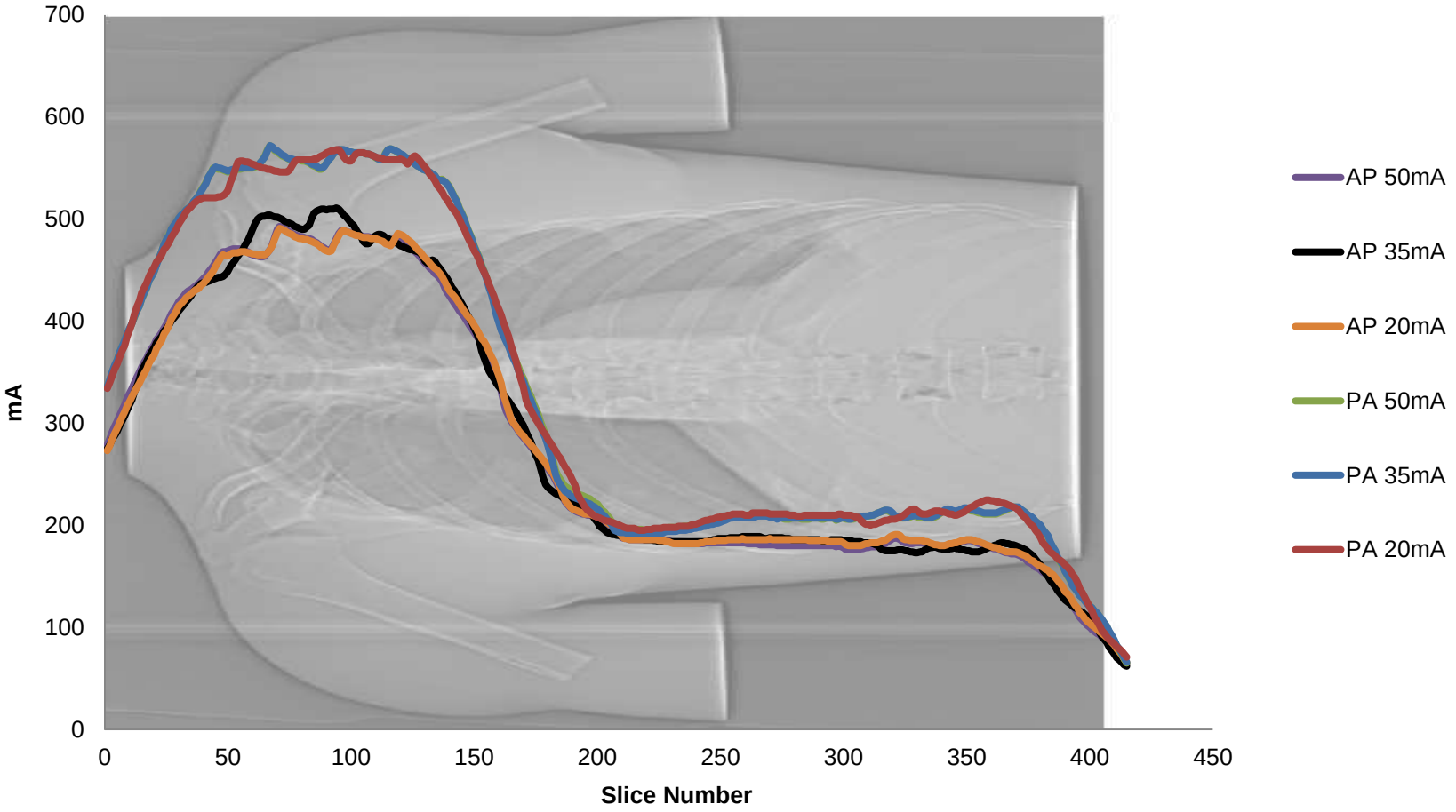
- Higher mA per slice in some regions for lateral only SPR than for dual or PA
  - $CTDI_{VOL}$ constant due to increased dose in thoracic region and decreased dose in lumbar spine region
  - However effective dose will be different

Results – Toshiba Aquilion 64 Scanner

View	mA	$CTDI_{VOL}$ [mGy]
Dual PA Lateral	50 100	5.6
Dual PA Lateral	50 50	5.6
Dual PA Lateral	35 35	5.6
Dual PA Lateral	10 10	5.6
PA	50	5.7
PA	35	5.7
PA	10	5.7
Lateral	100	5.6
Lateral	50	5.6
Lateral	35	5.7
Lateral	10	5.6

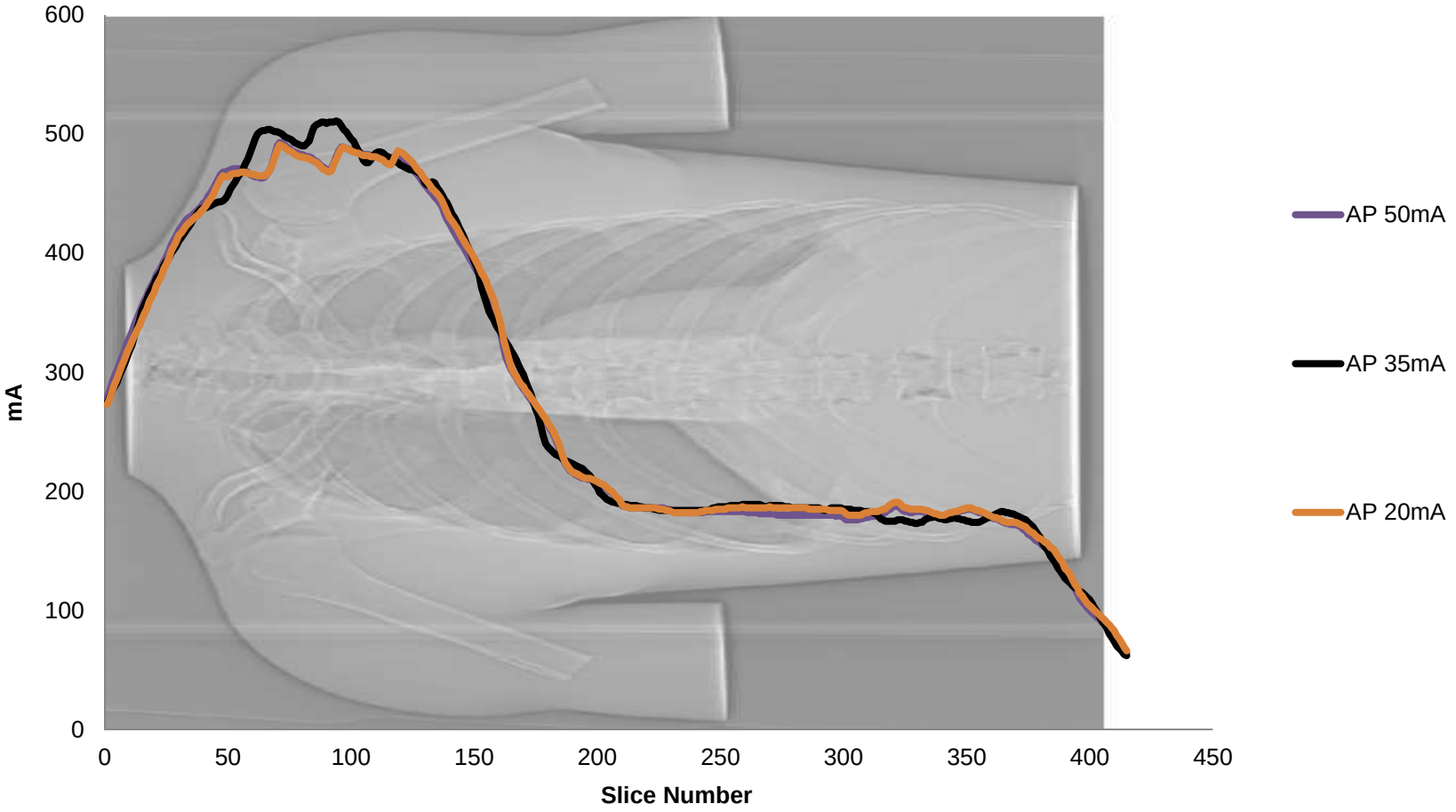
Results – Siemens Definition AS Scanner

- Default SPR: AP SPR at 35 mA



Results – Siemens Definition AS Scanner

- AP SPRs at 50 mA, 35 mA and 20 mA

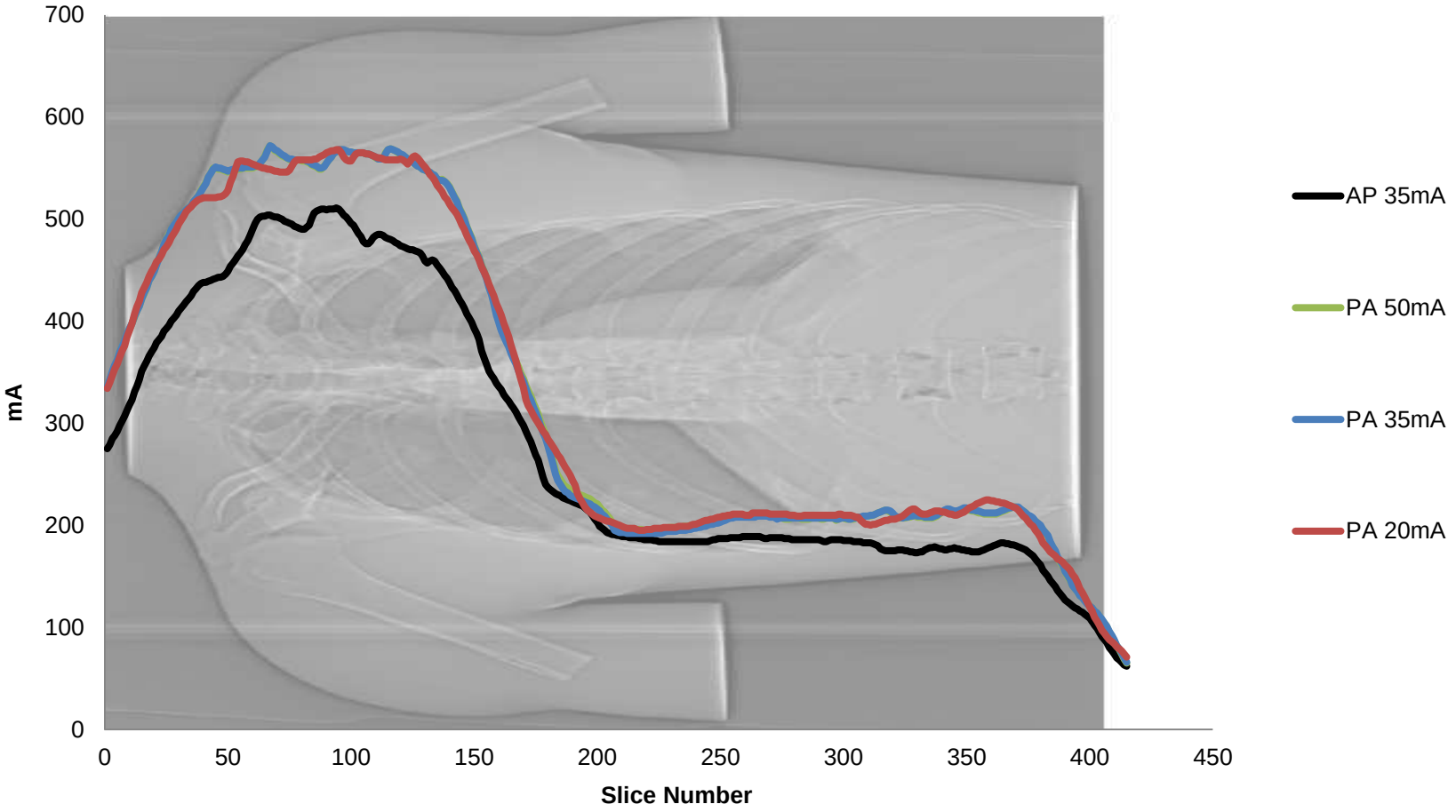


Results – Siemens Definition AS Scanner

- Reducing AP SPR mA from 50 mA to 20 mA had little effect on CT mAs modulation
  - ➢ $CTDI_{VOL}$ remained constant for all values of mA

Results – Siemens Definition AS Scanner

- PA SPRs at 50mA, 35 mA and 20 mA



Results – Siemens Definition AS Scanner

- Reducing PA SPR mA from 50 mA to 20 mA had little effect on CT mAs modulation
  - ➢ $CTDI_{VOL}$ remained constant for all values of mA

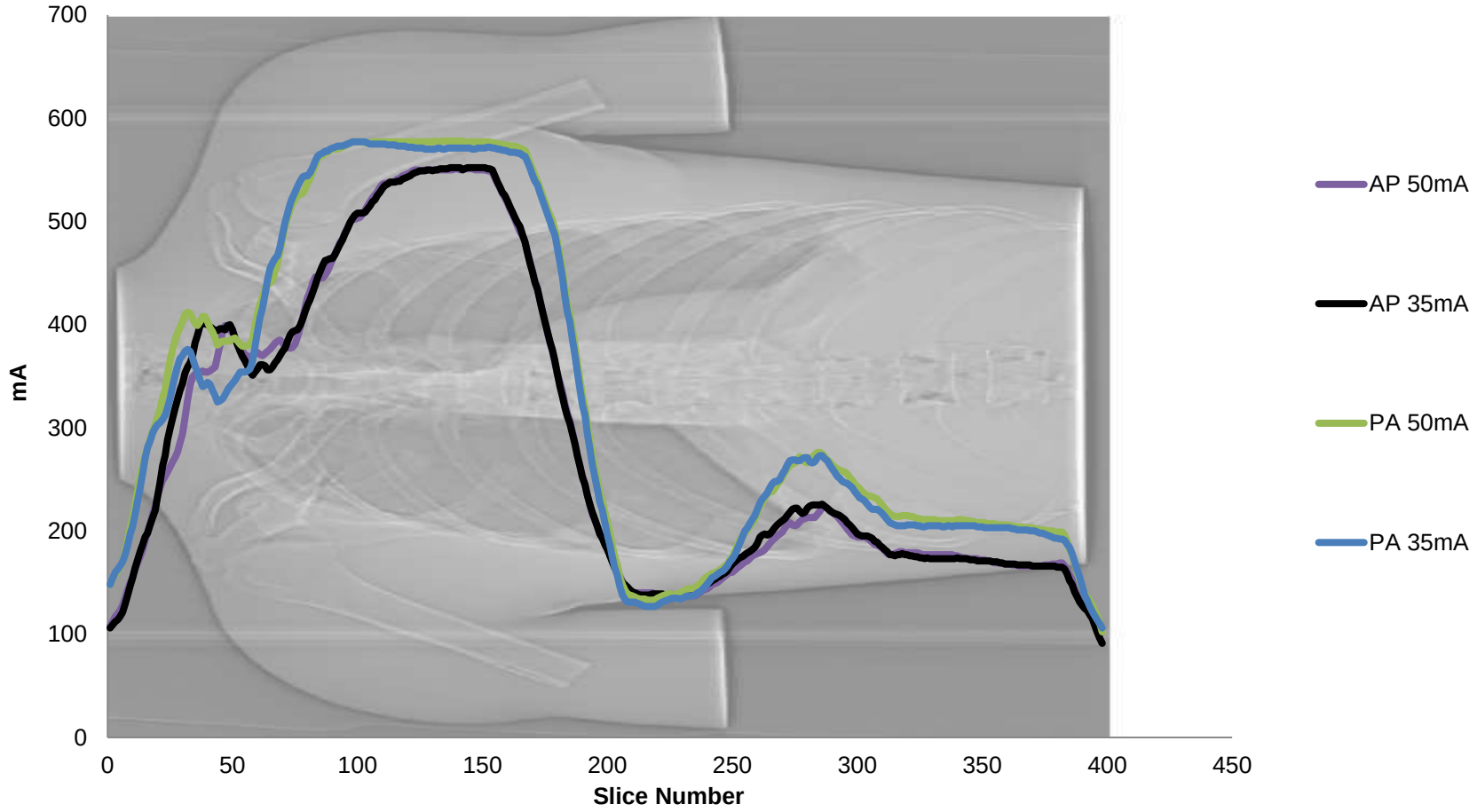
- However the CT mA per slice is higher for PA SPRs than for AP
  - ➢ Increase in $CTDI_{VOL}$ from 8.04 mGy to 9.31 mGy

Results – Siemens Definition AS Scanner

View	mA	$CTDI_{VOL}$ [mGy]
AP	50	8.04
AP	35	8.04
AP	20	8.04
PA	50	9.31
PA	35	9.31
PA	20	9.31

Results – Siemens Sensation 64 Scanner

- Default SPR: AP SPR at 35 mA
  - SPR mA could not be reduced below 35 mA



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Results – Siemens Sensation 64 Scanner

- Similar results to DCN Siemens scanner
  - Reducing SPR mA within a single view had very little effect on CT mA modulation
  - $CTDI_{VOL}$ remained constant
  - Higher mA per slice and $CTDI_{VOL}$ for PA SPR
- Default SPR setting already uses lowest exposure factors

Discussion – All Systems

- Within a single view SPR mA could be reduced without little effect on CT mA modulation

- We found that for dual SPRs one view could be removed without affecting CT mA modulation
  - For Philips: CT mA modulation for a dual SPR was the same as for lateral only SPR
  - For Toshiba: CT mA modulation for a dual SPR was the same as for PA SPR only
  - Need to know which SPR determines the CT modulation: may always be one view or may depend on order performed

- Our findings suggest that single view SPRs with lowest or reduced mA could be used

Discussion – All Systems

- Manufacturer Response

- Toshiba
  - Historically lateral SPR for XY modulation, PA for Z modulation
  - XYZ modulation performed with single SPR
  - Dual SPR only recommended for improved patient positioning and FOV selection
  - Recommended to reduce the SPR mA wherever possible

- Siemens
  - Have encouraged users to use AP SPR in order to reduce CT effective dose
  - This is despite increased SPR effective dose

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Discussion – All Systems

System	Default SPR Settings	Recommended based on results	Change in CTDIvol [mGy]
Phillips Brilliance Big Bore	PA 30 mA	PA 20 mA	0.0
Toshiba Aquilion 64	PA 50 mA Lateral 100 mA	PA 35 mA	0.1
Siemens Definition AS	AP 35 mA	AP 20 mA*	0.0
Siemens Sensation 64	AP 35 mA	AP 35 mA*	0.0

* With careful patient positioning the magnification of the spine in PA SPR views which causes increased CT effective dose could be mitigated allowing use of PA SPRs

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Future Work

- CT image quality analysis required

- Radiologist and radiographer input
  - SPRs not used as aid to diagnosis
  - Reduced dose SPR must not inhibit patient positioning

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Future Work

- Investigate range of protocols
  - Paediatric scanning

- Assess the impact of changing SPR kV on CT acquisition

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Thank you for listening!

Questions?