United Lincolnshire Teaching Hospitals NHS Trust

Matching reconstruction kernels based on noise power spectrum

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Radiation Protection & Radiology Physics
United Lincolnshire Teaching Hospitals NHS Trust

Scan
Doe Jane
ID: 111
Apps
23 Jun 2022 13:56
75%
13%
Adult
Child
Whole
Head
Neck
Chest
Arm
Abdomen
Pelvis
Leg
Protocols
Abdomen (Non)
Abdomen Angio (Art)
Renal CTA
KUB
Abdomen Angio (Non+Art+SureSub)
IVP (<50yrs) (Non+Neph)
Abdomen (Delayed)
Adrenal 3 Phase (Non+PV+Del)
IVP (>50yrs) (Non+Neph+Del)
Abdomen (PV)
Pancreas 3 Phase (Non+Art+PV)
Kidney 4 Phase (Non+Art+PV+Del)
Abdomen 4 Phase (Non+Art+PV+Del)
Abdomen 4 Phase (+I-Maps)
FF: Feet First
SU: Supine
Abdomen (PV)
3D Scanogram
3D Landmark
Link
5.6 s
SURE Start
SURE Start
Link
40.5 s
40.0s
Portal Venous
Helical
Link
11.6 s
Back
Registration
Protocol
Scan
Review
Finish
Next

What have we done?

- Scanned a Catphan 500 phantom with a standard protocol
  - For each anatomically named INSTINX kernel (Serve SP, n=20)
  - For each numbered FC kernel (Prime SP, n=55)
- Calculated the noise power spectrum for each kernel
  - ImageJ NPS plugin [2]
  - Ran in headless mode using a new ImageJ plugin that enabled batch NPS analysis [3]
- For each Serve SP kernel, found the closest matching Prime SP kernel using a combination of the root mean square error and Pearson correlation coefficient [3]
- Taken advice from Canon CT colleagues regarding the clinical appropriateness of the NPS-matched kernels

The Canon Serve SP kernels

Body	Brain A1	Cardiac	CTA Body	QC-DS
Body+	Brain A2	Cardiac+	CTA Body+	QC-RS
Bone	Brain B1		CTA Brain	QC
Bone+	Brain B2	Lung		
Inner Ear	Brain Ped	Lung+		

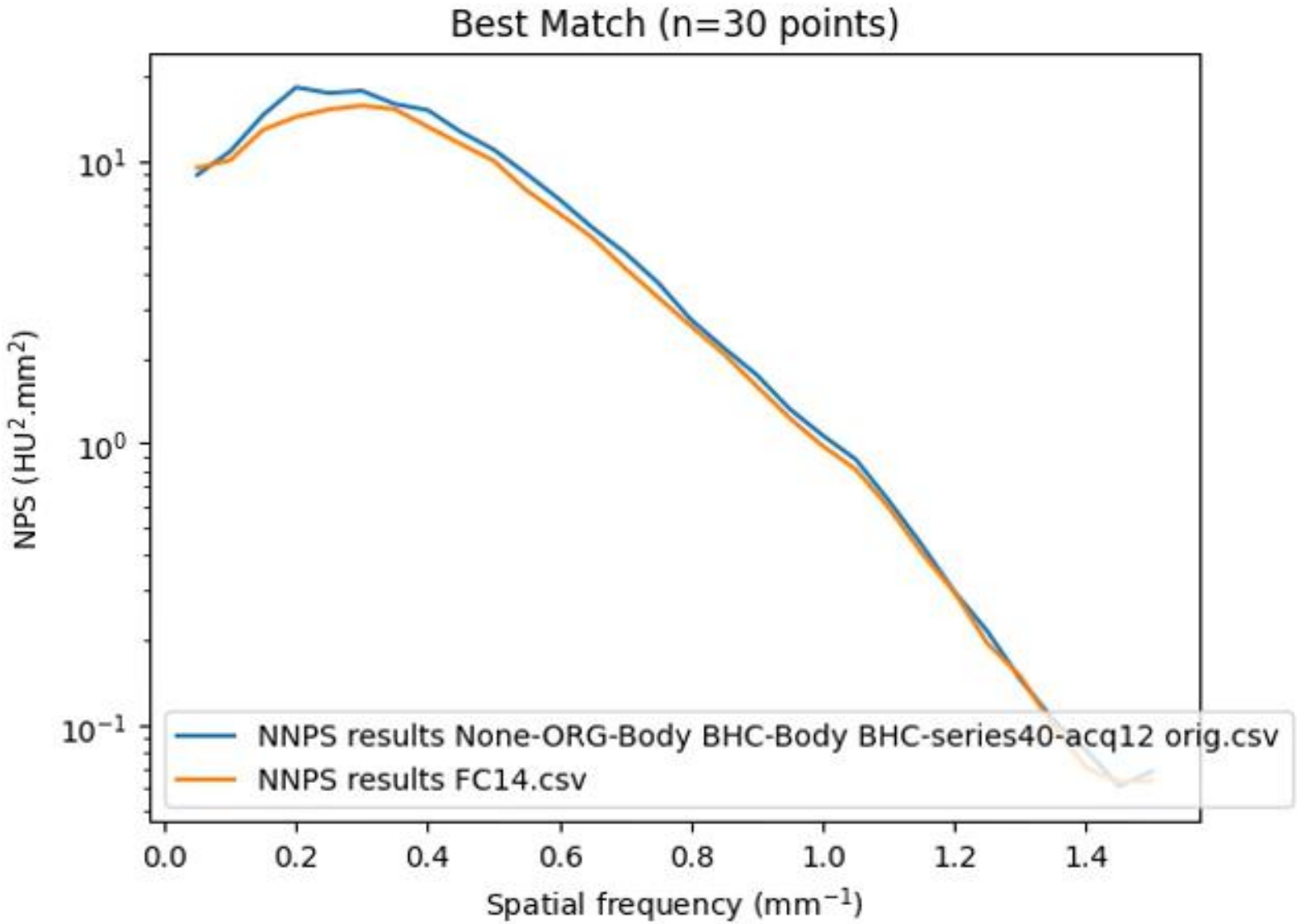
Some of the Canon Prime SP kernels

For the abdomen (with BHC processing)		**For the abdomen (without BHC processing)**		**For the head (with BHC processing)**		**For the head (with BHC processing)**	
Smooth	FC01	Smooth	FC11	Smooth	FC20	Smooth	FC62
	FC02		FC12		FC21		FC63
	FC03		FC13		FC22		FC64
	FC04		FC14		FC23		FC65
Sharp	FC05	Sharp	FC15		FC24		FC66
					FC25		FC67
				Sharp	FC26	Sharp	FC68

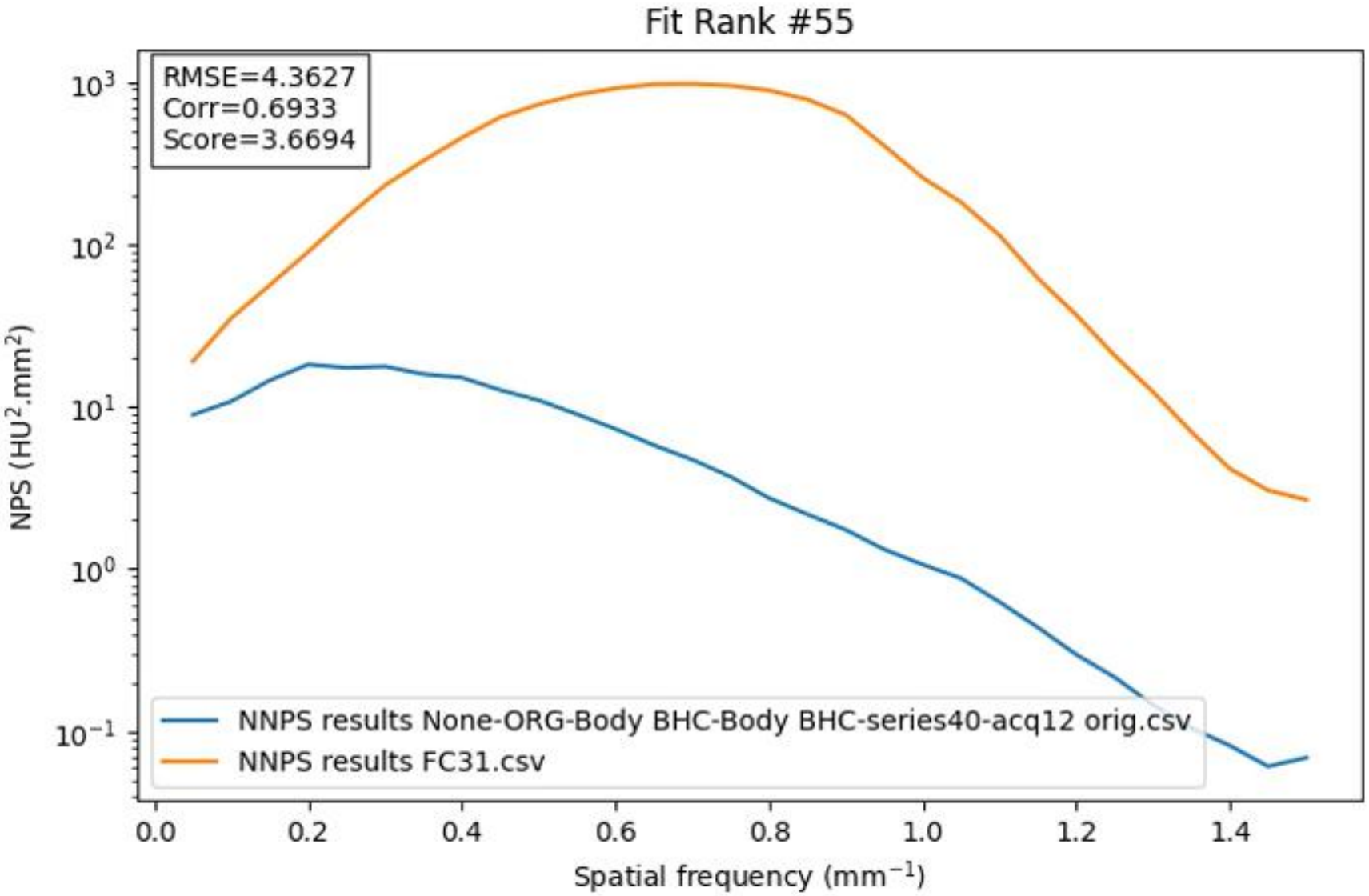
Scan protocol

- Attempted to set up identical protocols on the two systems
  - 120 kVp
  - 300 mA
  - 1 s rotation time
  - 0.625 pitch
  - 40 x 0.5 mm collimation
  - 5 mm reconstructed slice thickness
  - All optional / additional filters switched off
  - Helical scan of the whole Catphan

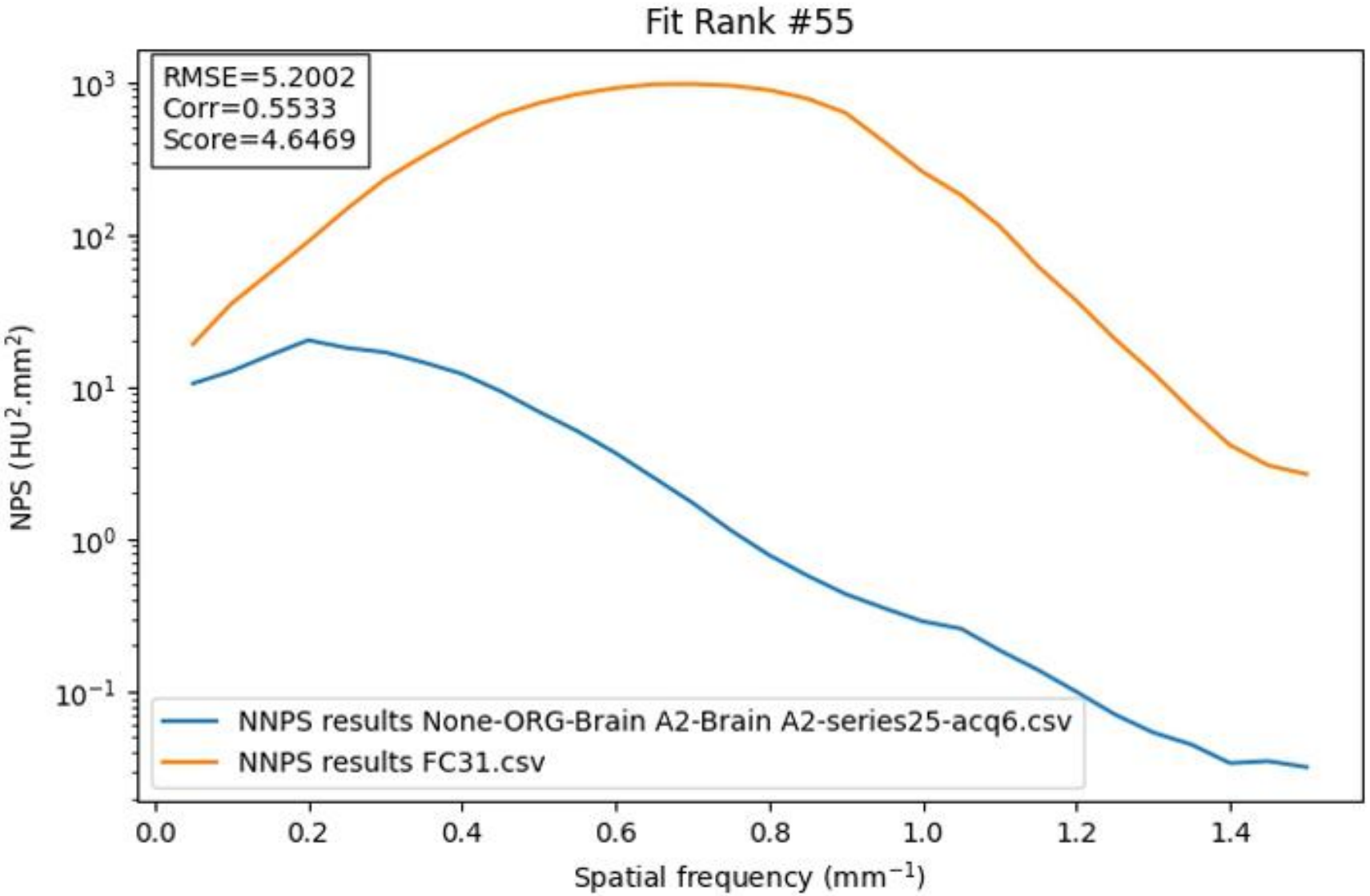
Results: highest ranked matches



Results: Body kernel



Results: Brain A2 kernel



Canon advice

- We shared our results with Canon CT colleagues
- Provided input into some of the matches
  - Beam hardening correction on / off
    - FC14 vs. FC4; FC18 vs. FC8 etc.)
  - Incorrect FC family
    - FC52 was best match for Bone Sharp, but is a specific lung kernel
  - Non-clinical QC protocols
    - FC70 was best match for CTA Body, but would not be clinically appropriate

Tabulated matching data 1 of 2

Body region	Serve SP kernel name	Prime SP #1 FC kernel (NPS matching)	Canon suggested kernel (NPS matching rank in brackets)
Brain	A1	26	**21 (#2)**
	A2	47	**26 (#6)**
	B1	62	62 (#1)
	B2	26	**68 (#2)**
	Paed	49	49 (#1)
Lung	Lung	52	52 (#1)
	Lung Sharp	53	53 (#1)
Body	Body	14	**4 (#3)** (4 = 14 with BHC)
	Body Sharp	18	**8 (#2)** (8 = 18 with BHC)

Tabulated matching data 2 of 2

Body region	Serve SP kernel name	Prime SP #1 FC kernel (NPS matching)	Canon suggested kernel (NPS matching rank in brackets)
Cardiac	Cardiac	4	4 (#1)
	Cardiac Sharp	19	**9 (#2)** (9 = 19 with BHC)
CTA	Body	70 Non-clinical QC FC	**3 (#2)**
	Body +	8	8 (#1)
	Brain	44	44 (#1)
Bone	Inner Ear	81	81 (#1)
	Bone	30	30 (#1)
	Bone Sharp	52 Lung specific FC	**30 (#3)** (+Edge Enh?)
QC	QC	70	70 (#1)
	QC Res	30	30 (#1)
	QC Dens	41	41 (#1)

Points to note

- Our Serve SP and Prime SP scanning protocols were not identical
  - “LARGE” vs “MEDIUM” beam shaping filter
  - Difficult to be sure that all additional / optional filtering was disabled
  - Slightly different reconstruction field of view used between the scanners (250 mm vs. 247 mm)
- We’ve also looked at naming changes to AiCE and AIDR3D strength
  - Strengths used to be named (Mild, Standard, Strong etc.)
  - Strengths are now numbered
    - Results show strength increases with number
    - Results do not tally very well between names and numbers
      - May be due to difficulties ensuring Prime SP and Serve SP scan protocols were the same

Summary

- NPS comparison worked well to match kernels between scanners
- Automation was essential to enable efficient analysis and comparison
  - Microsoft Copilot, Google Gemini etc. should be your friends here, alongside human fine tuning, validation etc.
- It is essential to work with your vendor’s CT experts
- We hope others may find this work useful, and would encourage you all to share what you’re doing

Acknowledgements

- Many thanks to our Canon colleagues for their support:
  - Mark Condron, CT Clinical Development Manager
  - Laura McLennan, CT Clinical Development Specialist
  - Marco Caballo, European Clinical Scientist CT & Interventional X-ray

References

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3. ImageJ Jython NPS batch processing plugin, NPS matching Python script, sample DICOM images and results, https://bitbucket.org/dplatten/ct-nps-matching/
4. Solomon JB, Christianson O, Samei E. Quantitative comparison of noise texture across CT scanners from different manufacturers. Medical Physics. 2012 Oct;39(10):6048–55. https://doi.org/10.1118/1.4752209

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Any questions?

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Medical Physics Experts

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