

MWAX Correlator Update

Ian Morrison | 22nd June 2021

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- Hardware procurement status
- Software development status
- Validation status
- Preliminary commissioning timeline
- Preliminary release plan

Hardware Procurement Status

- ❑ MWAX design & development has been an ongoing Curtin project since 2018
- ❑ Funding approved late 2020
- ❑ Critical Design Review (CDR) conducted December 2020
 - Outcome: PASS
 - Extract from exec summary: “The review panel is satisfied that the design is capable of meeting the MWA science requirements and that risks are either low-impact or have adequate mitigation plans in place”.
- ❑ RFQ & procurement process from Feb-April 2021
 - order placed with CDM in May 2021
- ❑ Hardware received May-June (except for 7 NICs)

20 of 26 servers on
2 pallets @ CIRA



MWAX Server Specifications

(spec'd to support future 256T & oversampled coarse channels)

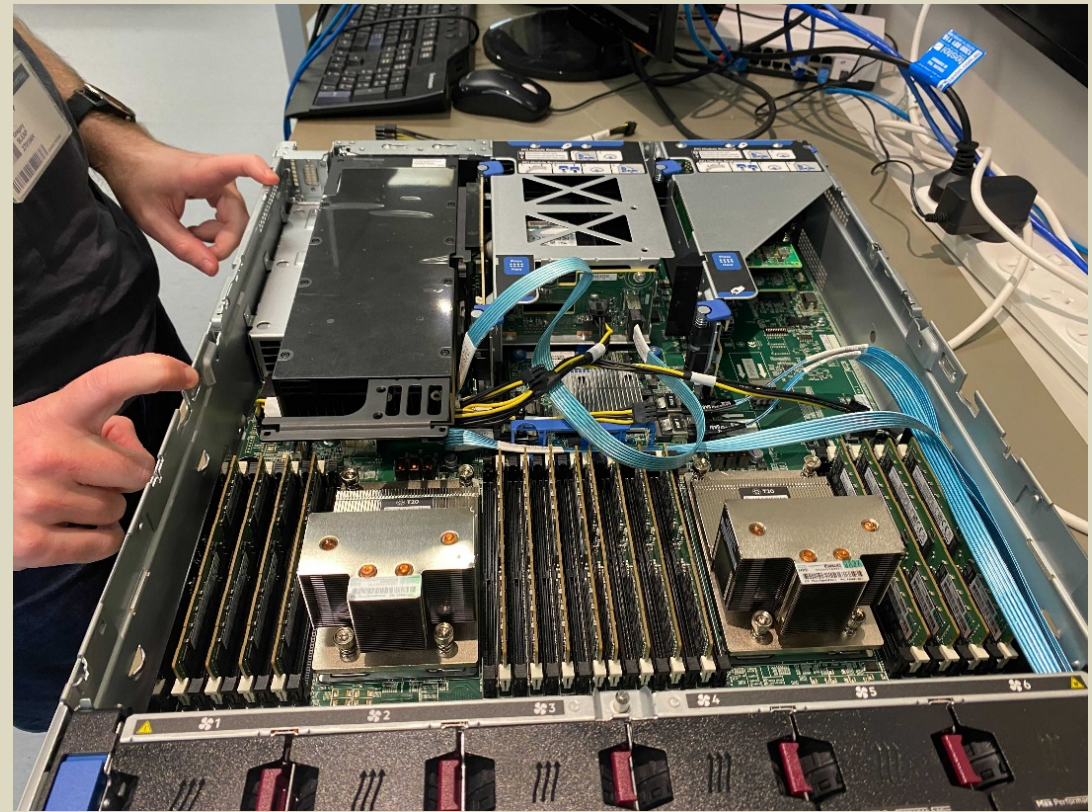
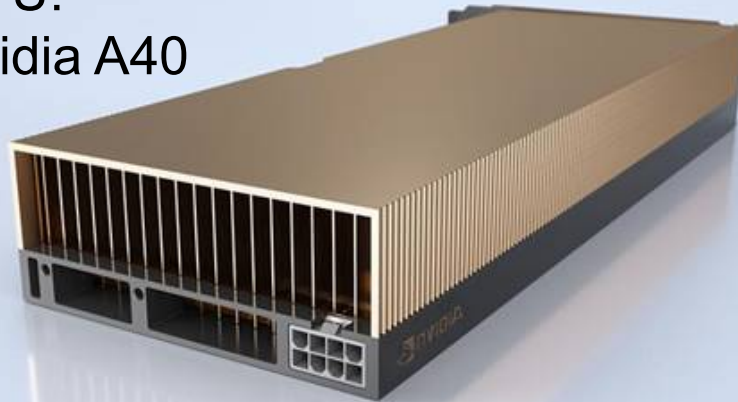
- 26 servers (24 active + 2 hot spares)
- 2 x AMD Epyc 7F72 CPU (3.2 GHz, 24 cores)
- 512 GB RAM
- Nvidia A40 GPU - 48 GB RAM (!)
- 2 x 480GB SSD boot drives (RAID 1)
- 12 x 6TB 3.5" HDD data drives (RAID 5) - ~25TB volume storage / ~25TB visibility storage
- Mellanox ConnexX-5 40 Gbps NIC (ingest of high time res. UDP multicast)
- Mellanox ConnexX-5 10 Gbps NIC (outbound to Perth)
- Dual redundant PSUs



Selected Server Model: HPe Proliant DL385 Gen10 Plus

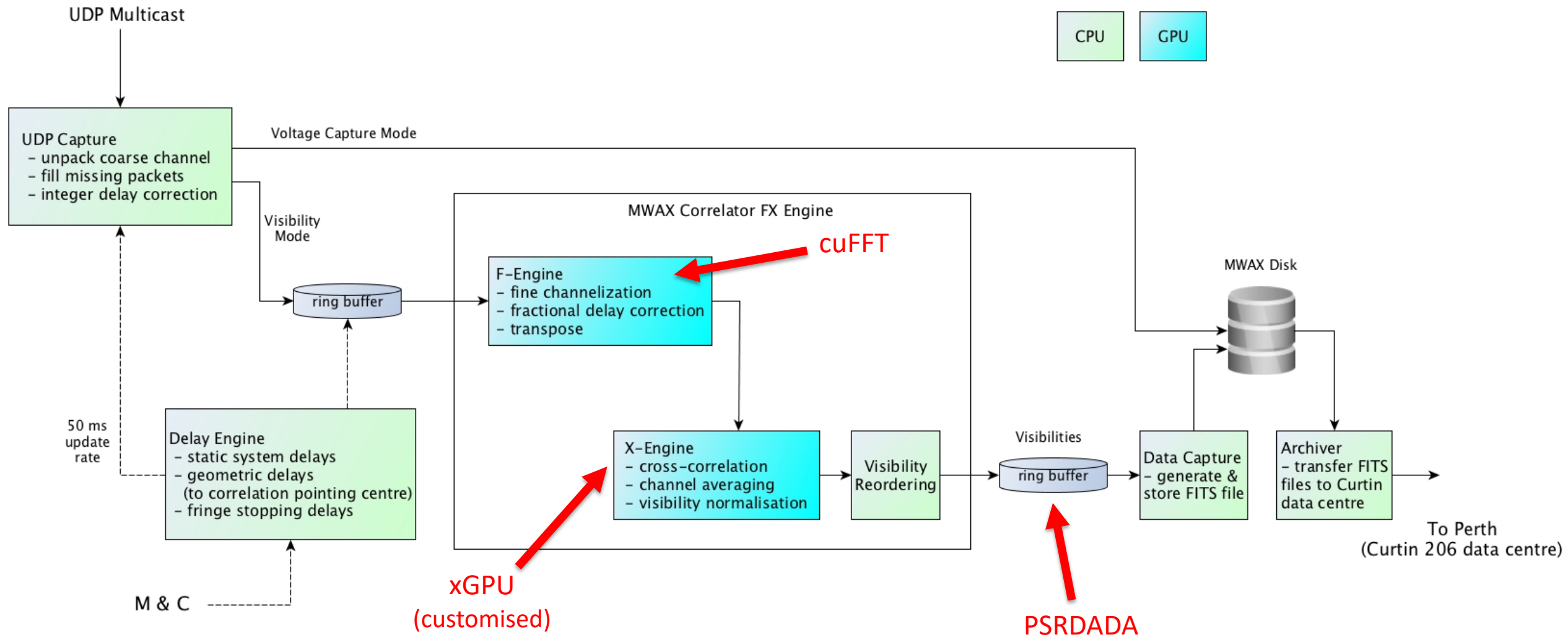


GPU:
Nvidia A40



MWAX Correlator – server software

MWAX Server – one per coarse channel



Software Development Status

- **Status:** UDP capture / correlation / FITS file generation completed
 - All modes (see next slide) tested and benchmarked up to 256T (although not yet with the procured hardware)
- **Recent changes:**
 - F-engine: ultrafine channel width 250 Hz → 200 Hz
 - X-engine: minimum integration time 200 ms → 250 ms (together these changes improve options freq/time resolution options and provide commonality with legacy options)
 - Visibility channel averaging: centre-symmetric fine channel boundaries (matching legacy)
 - M&C: health monitoring threads added
- **Current activities:**
 - M&C enhancements
 - Benchmarking with procured hardware
 - Testing and enhancements to deployment Ansible scripts
- **Future activities:**
 - Fringe stopping
 - Visibility weights
 - Further M&C enhancements

Release 1 Freq/Time Resolution Options

Total Combined Data Rate of Visibilities Output of MWAX 128T via 100G link (Gbps)

200Hz ultrafine resolution

			Time Resolution (s)						
			0.25	0.5	1	2	4	8	
Fine channels (per 1.28 MHz coarse channel)	fscrunch	count	width kHz						
	1	6400	0.2	1,293.52	646.76	323.38	161.69	80.85	40.42
	2	3200	0.4	646.76	323.38	161.69	80.85	40.42	20.21
	4	1600	0.8	323.38	161.69	80.85	40.42	20.21	10.11
	5	1280	1.0	258.70	129.35	64.68	32.34	16.17	8.08
	8	800	1.6	161.69	80.85	40.42	20.21	10.11	5.05
	10	640	2.0	129.35	64.68	32.34	16.17	8.08	4.04
	16	400	3.2	80.85	40.42	20.21	10.11	5.05	2.53
	20	320	4.0	64.68	32.34	16.17	8.08	4.04	2.02
	25	256	5.0	51.74	25.87	12.94	6.47	3.23	1.62
	32	200	6.4	40.42	20.21	10.11	5.05	2.53	1.26
	40	160	8.0	32.34	16.17	8.08	4.04	2.02	1.01
	50	128	10.0	25.87	12.94	6.47	3.23	1.62	0.81
	64	100	12.8	20.21	10.11	5.05	2.53	1.26	0.63
	80	80	16.0	16.17	8.08	4.04	2.02	1.01	0.51
	100	64	20.0	12.94	6.47	3.23	1.62	0.81	0.40
	128	50	25.6	10.11	5.05	2.53	1.26	0.63	0.32
	160	40	32.0	8.08	4.04	2.02	1.01	0.51	0.25
	200	32	40.0	6.47	3.23	1.62	0.81	0.40	0.20
	256	25	51.2	5.05	2.53	1.26	0.63	0.32	0.16
320	20	64.0	4.04	2.02	1.01	0.51	0.25	0.13	
400	16	80.0	3.23	1.62	0.81	0.40	0.20	0.10	
640	10	128.0	2.02	1.01	0.51	0.25	0.13	0.06	
800	8	160.0	1.62	0.81	0.40	0.20	0.10	0.05	
1280	5	256.0	1.01	0.51	0.25	0.13	0.06	0.03	
1600	4	320.0	0.81	0.40	0.20	0.10	0.05	0.03	
3200	2	640.0	0.40	0.20	0.10	0.05	0.03	0.01	
6400	1	1,280.0	0.20	0.10	0.05	0.03	0.01	0.01	

Based on 256T correlated and 30.72 MHz instantaneous bandwidth

- n.nn Gbps Supported realtime correlator mode at 128T (number is combined Gbps output)
- n.nn Gbps Correlator mode at 128T is not supported in realtime, but may be possible for short durations subject to final hardware specifications. (number is combined Gbps output)
- Existing legacy correlator mode

Validation

- Unit tests: [manual visibility inspection](#)
- End-to-end UDP capture → correlation → FITS file generation: [manual visibility inspection](#)
- Image comparisons: [MWAX first light vs legacy](#)

MWAX Correlator – first light

legacy correlator



MWAX correlator



Validation

- Unit tests: [manual visibility inspection](#)
- End-to-end UDP capture → correlation → FITS file generation: [manual visibility inspection](#)
- Image comparisons: [MWAX first light vs legacy](#)
- Visibility comparisons: [MWAX vs legacy, commensal capture](#)
[Comparisons using python tools based on “mwalib”](#)

Validation

Commensal observations

Both the legacy and MWAX correlators running

Also VCS capture of coarse channel voltages for offline MWAX reprocessing

May 2021 Commensal Observations

Created by Greg Sleep, last modified on May 19, 2021

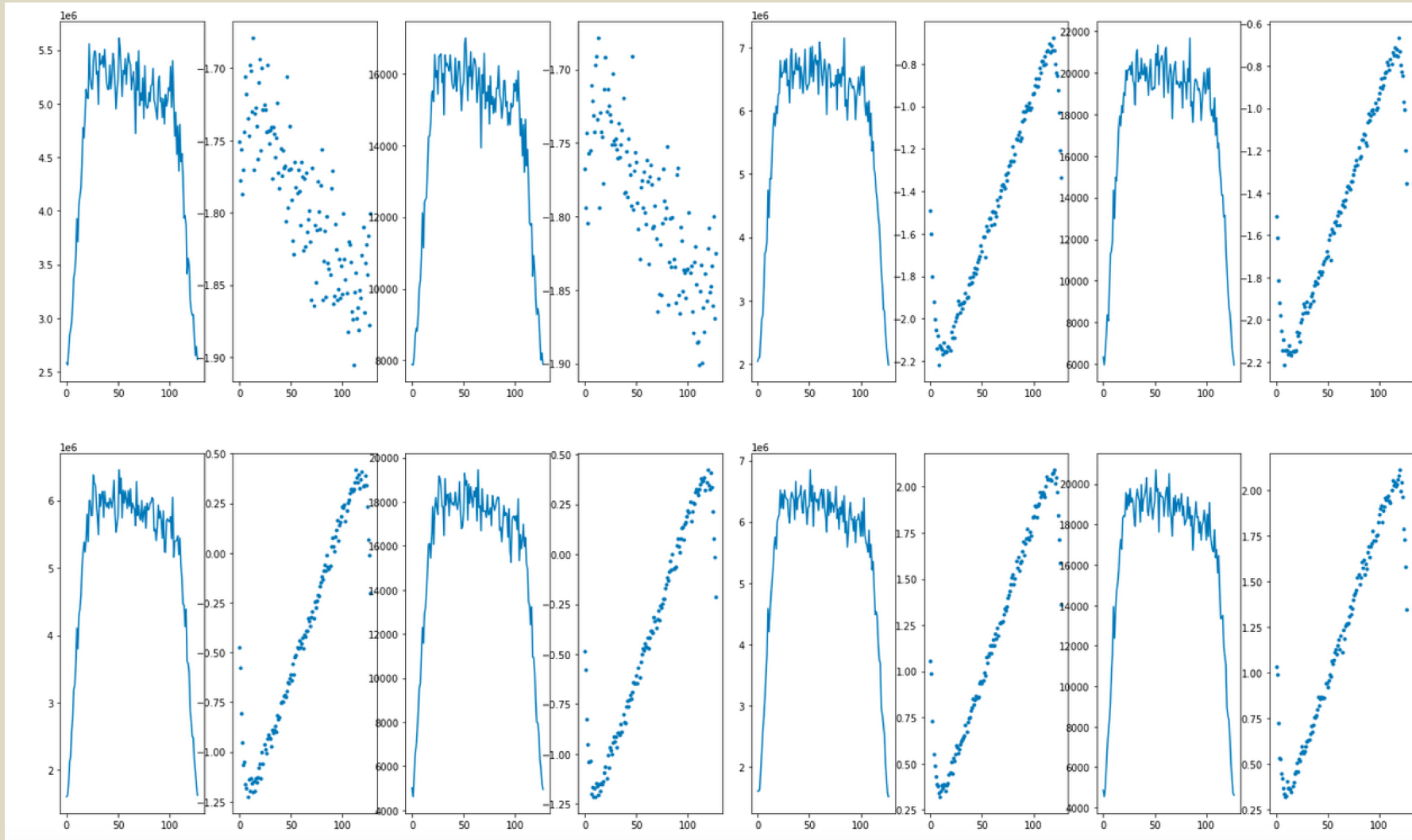
Several commensal observations were conducted May 11/12 2021 with the MWA and MWAX correlators.

Date/Time (UTC+8)	ObsID	Obs Name	Duration	Info	mwax101 gpubox09	mwax102 gpubox10	mwax103 gpubox11	mwax107 gpubox12	mwax105 gpubox13
2021-05-12 11:56:06	1304826984	mwax-Sun-good_Sun_Ch69	64	View	65	66	67	68	69
2021-05-12 11:57:10	1304827048	mwax-Sun-good_Sun_Ch93	64	View	89	90	91	92	93
2021-05-12 11:58:14	1304827112	mwax-Sun-good_Sun_Ch121	64	View	117	118	119	120	121
2021-05-12 11:59:18	1304827176	mwax-Sun-good_Sun_Ch145	64	View	148	147	146	145	144
2021-05-12 12:00:22	1304827240	mwax-Sun-good_Sun_Ch169	64	View	172	171	170	169	168
2021-05-12 12:10:54	1304827872	mwaxmilstats2_AzEI0.0,90.0_Ch195	64	View	198	197	196	195	194
2021-05-12 12:18:46	1304828344	mwaxgero_AzEI236.0,31.0_Ch77	64	View	73	74	75	76	77

Validation

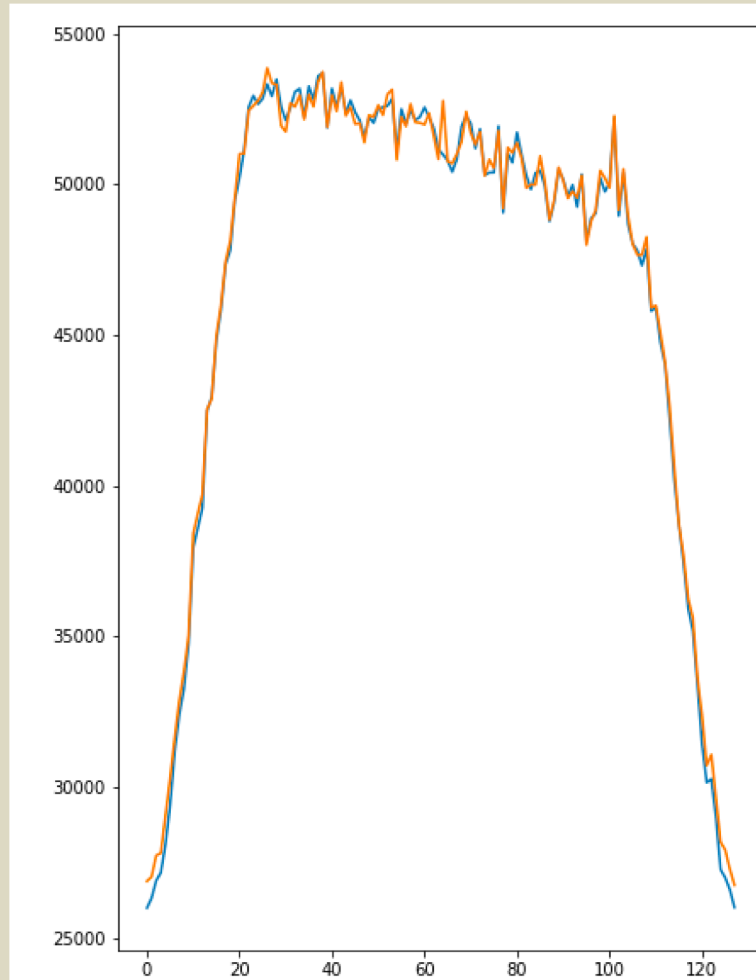
First four baselines, all channels

Pairwise MWAX vs Legacy

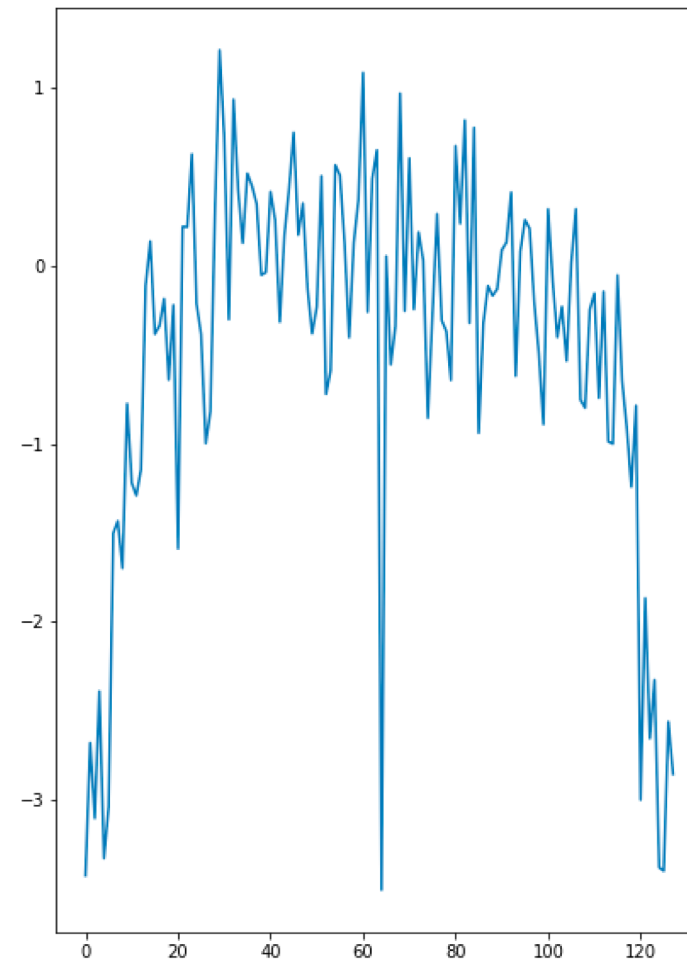


Validation

Single baseline, all channels



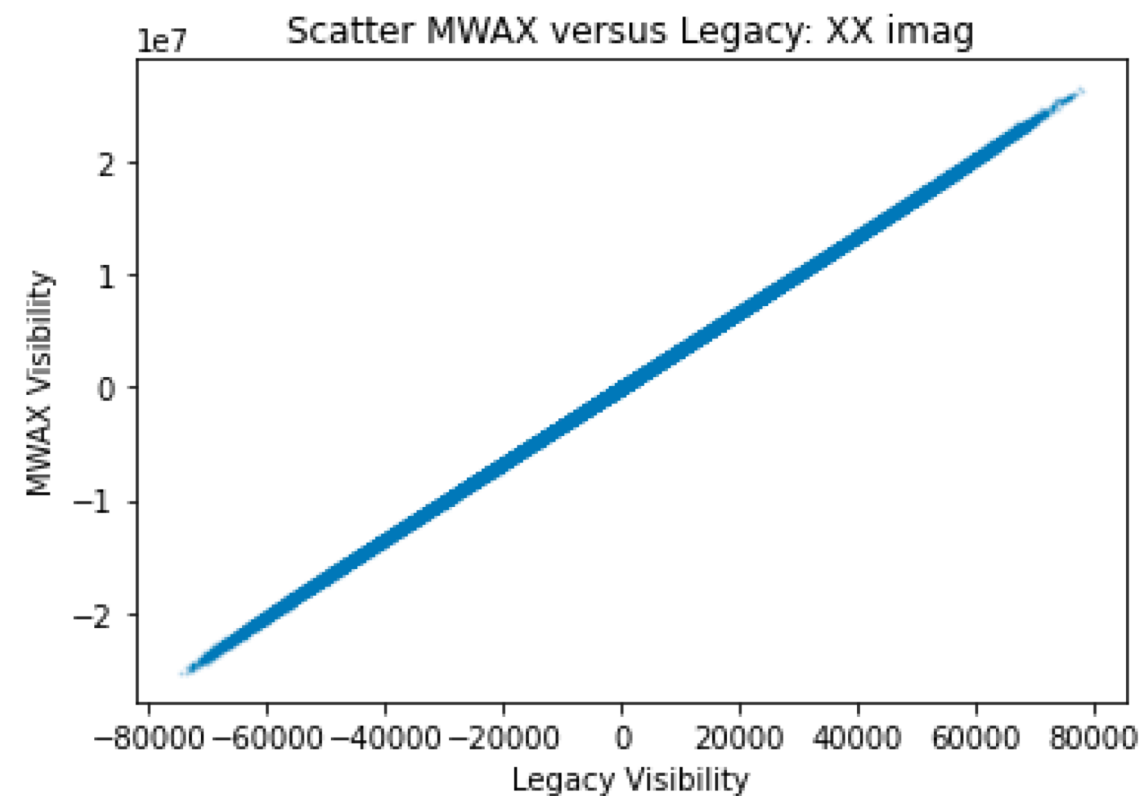
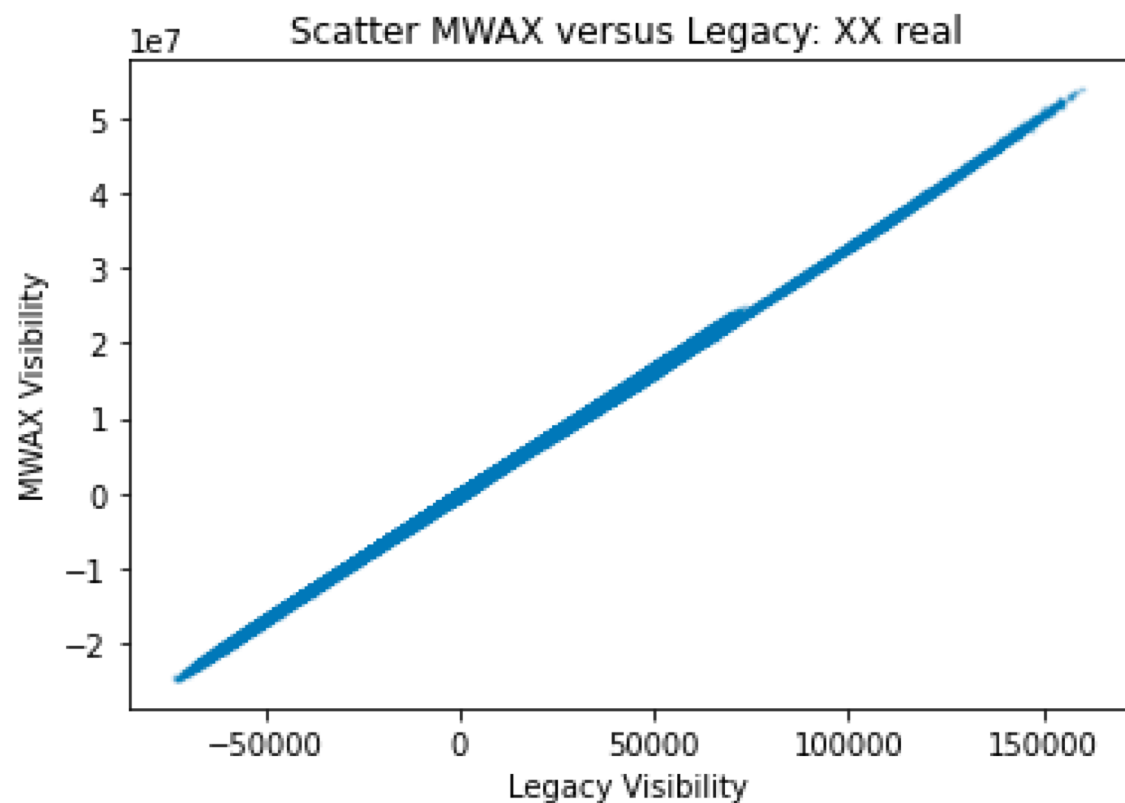
Percentage difference



Validation

Scatter diagrams: MWAX vs Legacy

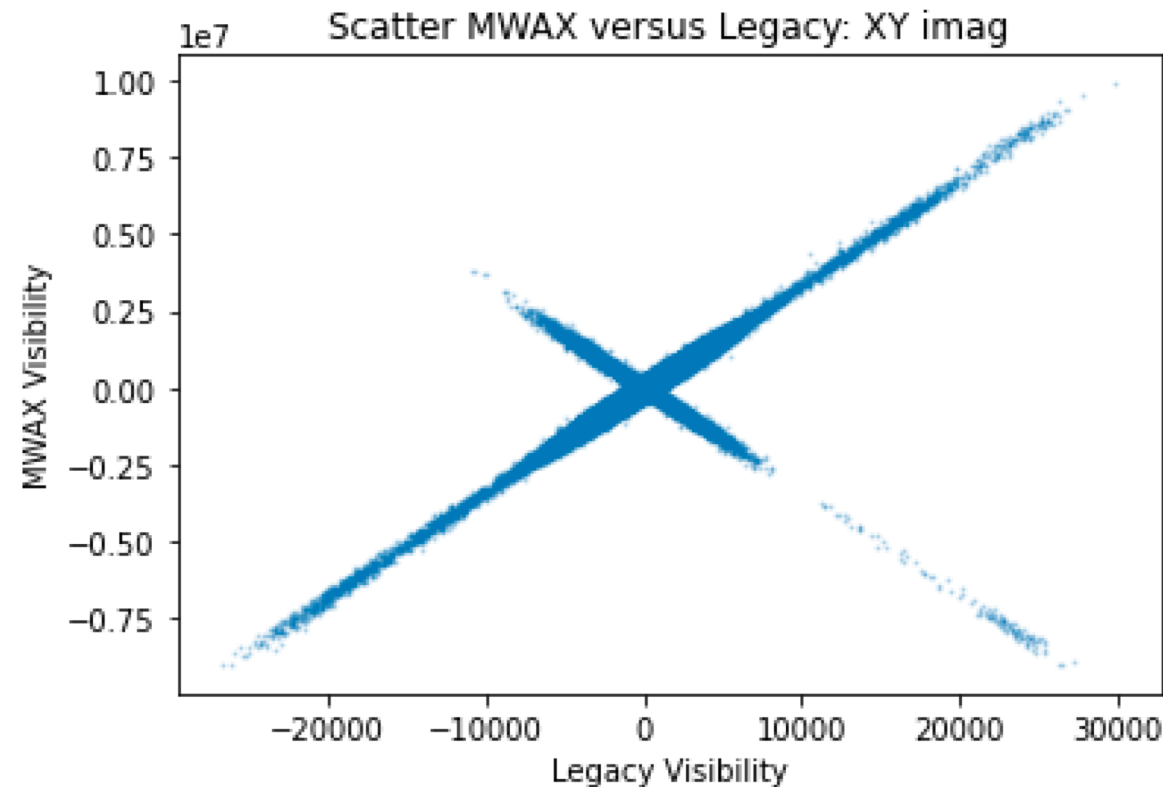
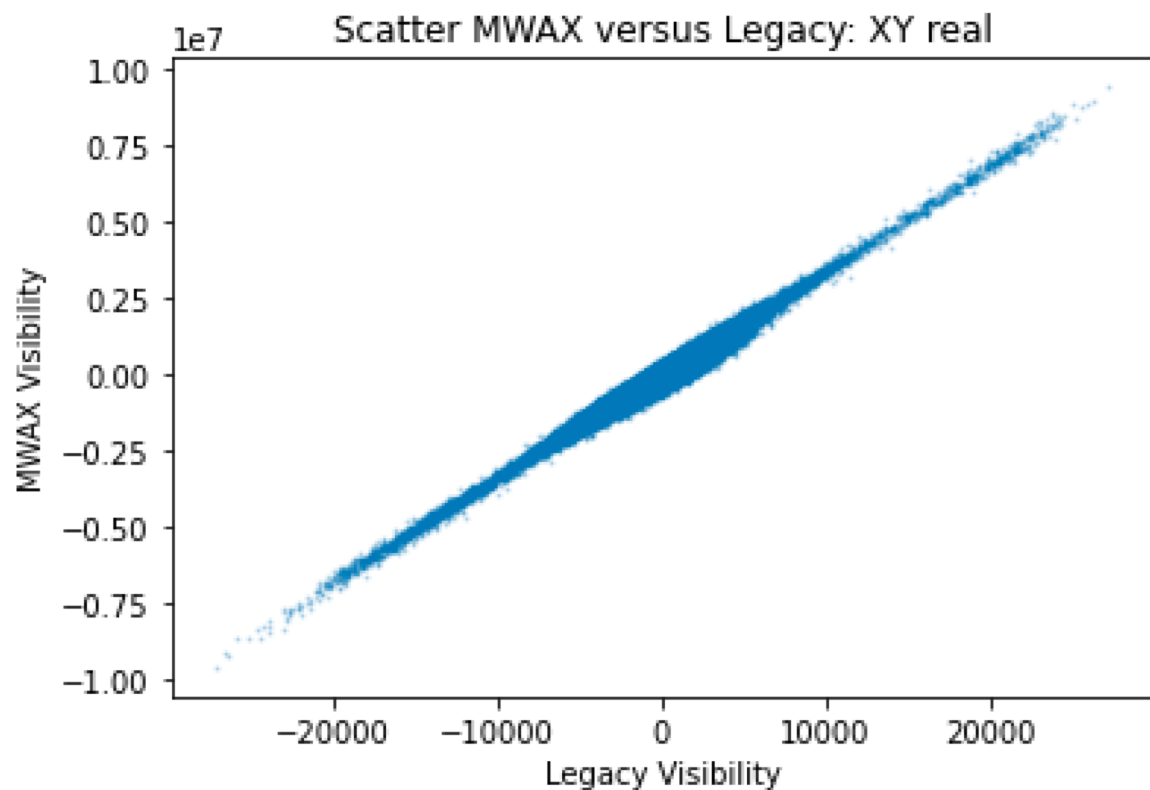
→ All points should lie on a straight line of positive slope



Validation

Scatter diagrams: MWAX vs Legacy

→ All points should lie on a straight line of positive slope



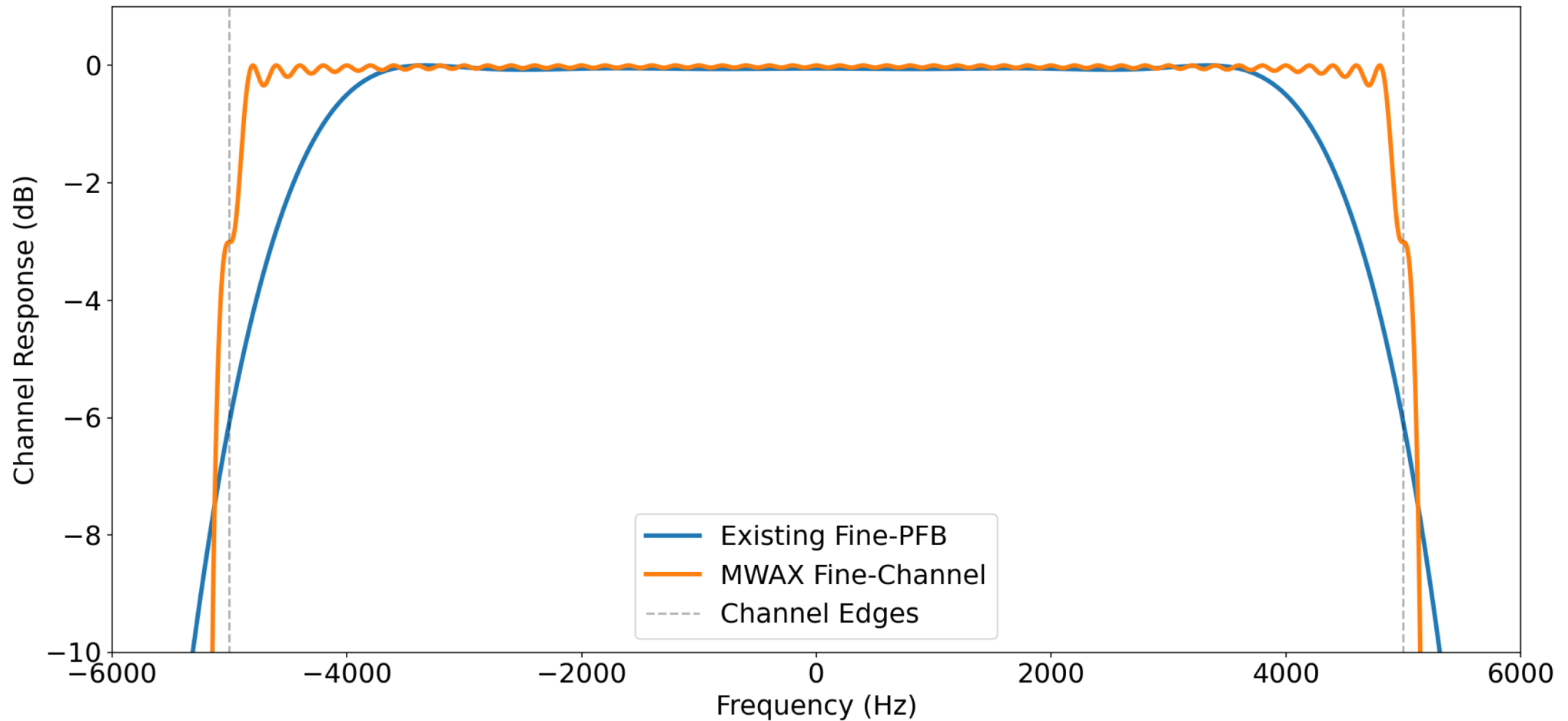
Validation

Differences explained by:

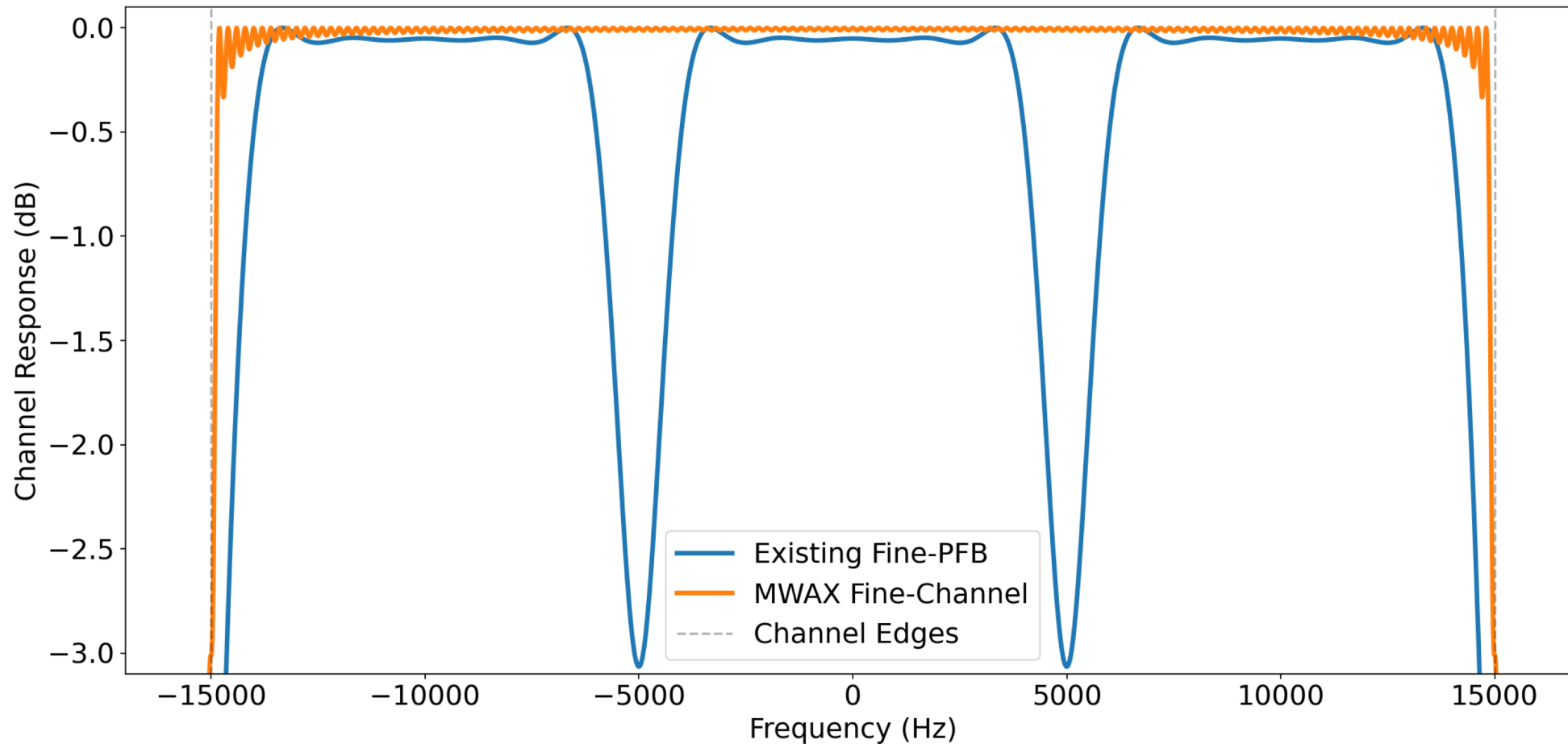
- fine channel passband shape differences
- quantisation differences

MWAX advantageous for both

Fine Channel Frequency Response MWAX vs Legacy



Fine Channel Frequency Response MWAX vs Legacy



Preliminary Commissioning Timeline

- **Now:**
 - Acceptance testing (thermal, performance, power) and any remediation with HPe
 - Prep single MWAX server to go to MRO for initial end-to-end testing

- **Q3/4:**
 - Decommission of existing correlator and conversion of VCS servers to medconv servers
 - Decommission fine PFB & associated equipment
 - Deployment of remaining 25 MAX servers to MRO
 - Initial commissioning, basic functional testing, M&C testing
 - Commence engineering commissioning
 - Conclude engineering commissioning
 - Commence science commissioning
 - Conclude science commissioning

Preliminary Release Plan

- Q3/4 2021: Release 1
 - Legacy replacement
 - Additional freq/time resolution options (as already shown)
 - 128T but 256+T ready

- Additional functionality being explored
 - Fringe stopping
 - Visibility weights
 - Oversampled coarse channels
 - Real-time tied-array beamforming



THANK YOU

Make tomorrow better.