
Hydraulic Fracturing Well 16B(78)-32 April 2024 DAS Based Frac Fluid Injection Efficiency Relative Cluster Fluid Allocation Estimation And Frac Plug Efficacy Analysis

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Acknowledgements



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We thank the many stakeholders who are supporting this project, including Smithfield, Utah School and Institutional Trust Lands Administration, and Beaver County as well as the Utah Governor’s Office of Energy Development and Utah’s Congressional Delegation.

During field operations, Neubrex worked with many operational experts and received critical assistance from many people, including John McLennan, Joseph Moore, Kevin England, Leroy Swearingen, Alan Reynolds, Garth Larson, Monty Keown, Dr. Mukul Sharma, Ben Dyer, Dr. Peter Meir, and Neubrex Ops Chief Wayne Fishback. The frac, drilling, water management crews and HSE managers were instrumental in getting the surface and downhole work accomplished in a safe and effective manner.

End of Technical Report and Contact Information



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Well 16B(78)-32: Designed Pumping Schedule

Stage Name	Number of Clusters	Fluid Type	Fluid Volume (bbl)	Pump Rate (bpm)	100-mesh Prop Volume (lb _m)	40/70-mesh Prop Volume (lb _m)	Comments
Stage 1	4	Slickwater	3,200	60	43,680	63,840	
Stage 2	5	Slickwater	3,200	60	43,680	63,840	
Stage 3	3	Slickwater	3,200	60	43,680	63,840	
Stage 4	4	Slickwater	3,200	60	43,680	63,840	
Stage 5	4	Slickwater	3,200	60	43,680	63,840	

Well 16B(78)-32: Actual Pumped

Stage Name	Number of Clusters	Fluid Type	Fluid Volume (bbl)	Pump Rate (bpm)	100-mesh Prop Volume (lb _m)	40/70-mesh Prop Volume (lb _m)	Comments
Stage 1	4	Slickwater	3,624	60 (Avg = 55)	45,600	66,840	
Stage 2	5	Slickwater	4,734	60 (Avg = 56)	46,770	102,000	
Stage 3	3	Slickwater	4,321	60 (Avg = 51)	43,322	70,163	
Stage 4	4	Slickwater	3,800	60 (Avg = 56)	43,217	65,317	
Stage 5	4	Slickwater	N/A	N/A	N/A	N/A	Did not pump Stage 5. No additional frac plug available to isolate Stage 4.

16B(78)-32 Plug and Perf Depths MD RKB

	A	B	C	D	E	F	G
2	Measured Depth (Referenced to KB = 31.5 ft)						
3		Gun 1	Gun 2	Gun 3	Gun 4	Gun 5	Frac Plug Top
4	Frac Plug #1						9,777
5	Stage 1 (16B)	9,769 - 9,773	9,756 - 9,760	9,745 - 9,749	9,690 - 9,694		
6	Frac Plug #2						9,600
7	Stage 2 (16B)	9,508 - 9,512	9,475 - 9,479	9,459 - 9,463	9,447 - 9,451	9,429 - 9,433	
8	Frac Plug #3						9,415
9	Stage 3 (16B)	9,389 - 9,393	9,343 - 9,347	9,265 - 9,269			
10	Frac Plug #4						9,165
11	Stage 4 (16B)	9,054 - 9,058	9,026 - 9,030	8,995 - 8,999	8,958 - 8,962		
12	Frac Plug #5						8,915
13	Stage 5 (16B)	8,879 - 8,883	8,870 - 8,874	8,834 - 8,838	8,774 - 8,778		



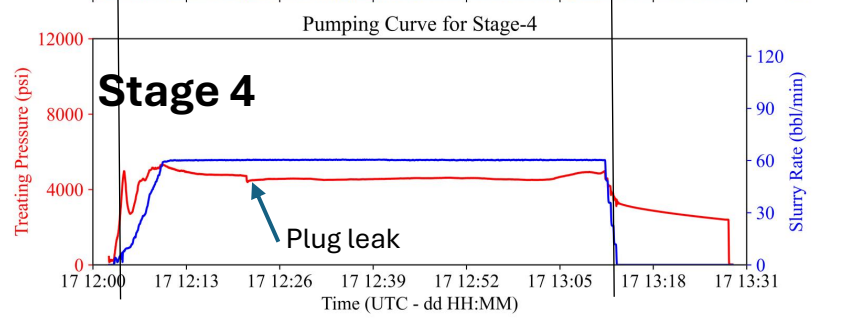
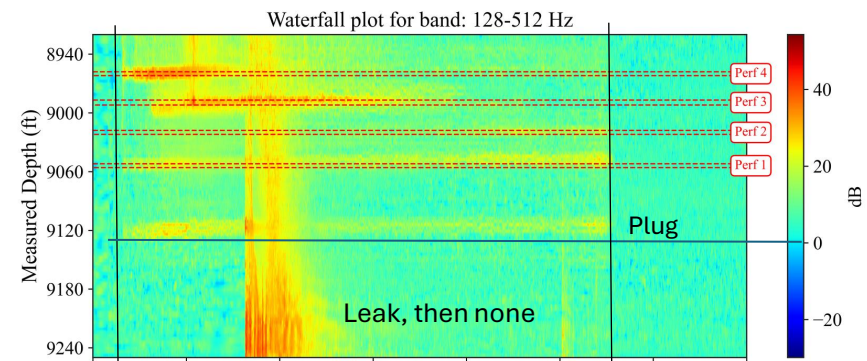
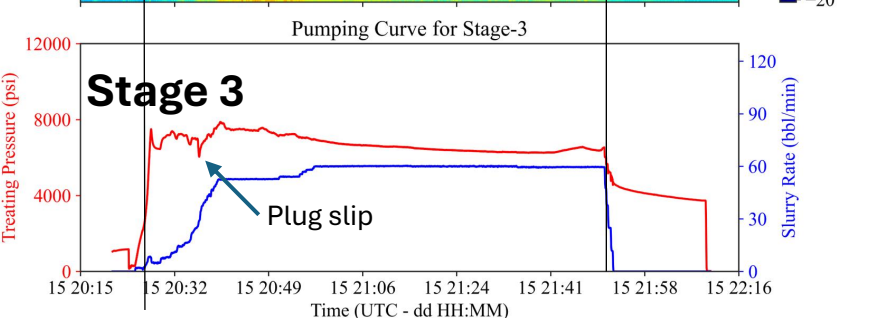
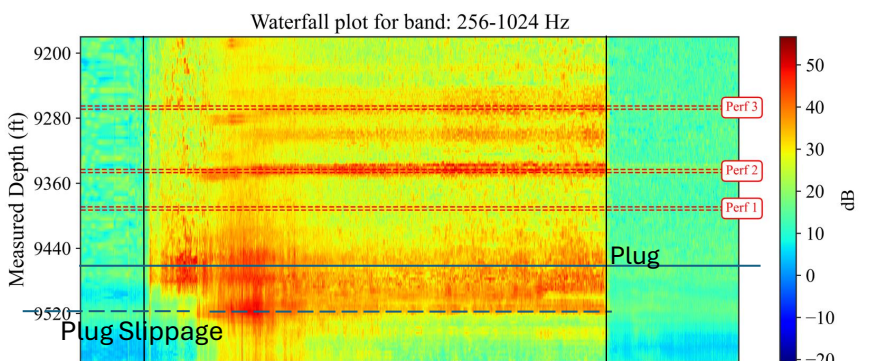
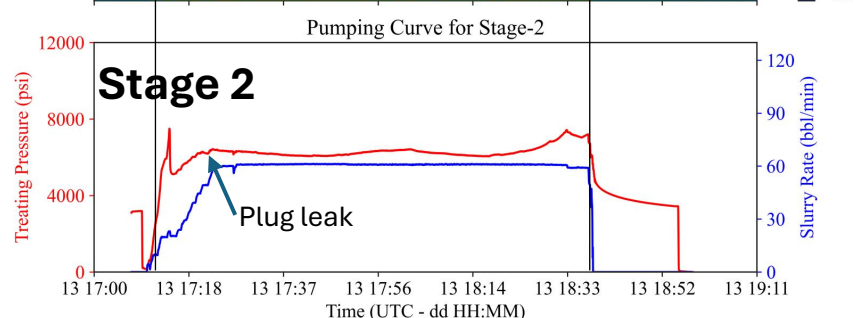
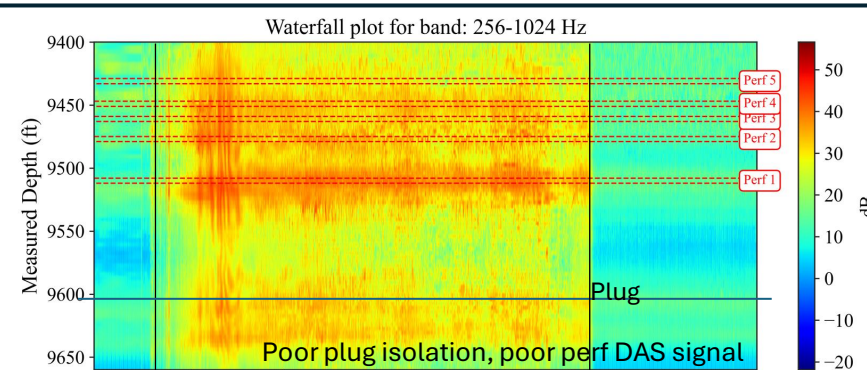
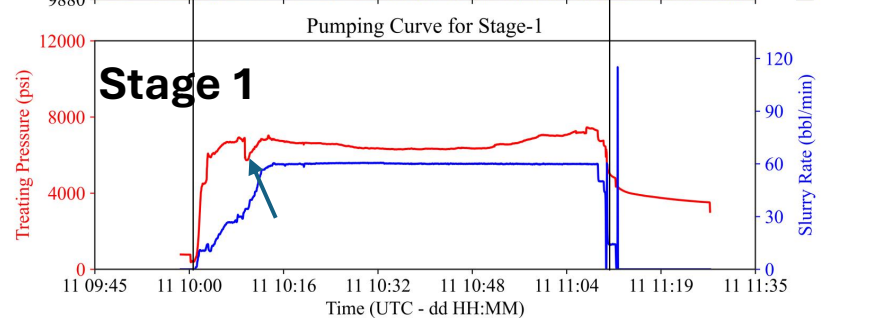
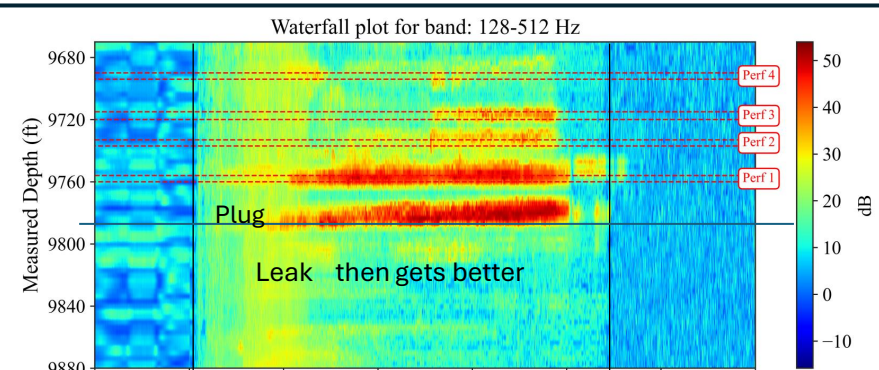
EXAMPLES
FROM
FORGE 16B

Utah FORGE
Well: 16B
In Well DAS Acoustics

Neubrex DAS
DAS Monitor
Frequency Range
Acquired
0-10,000 Hz
Processed:
0-4096 Hz
Shown: various bands

With Rate and Pressure
Pump Curves

Frac Injection Periods
Well 16B DAS Signals
Stages 1-4



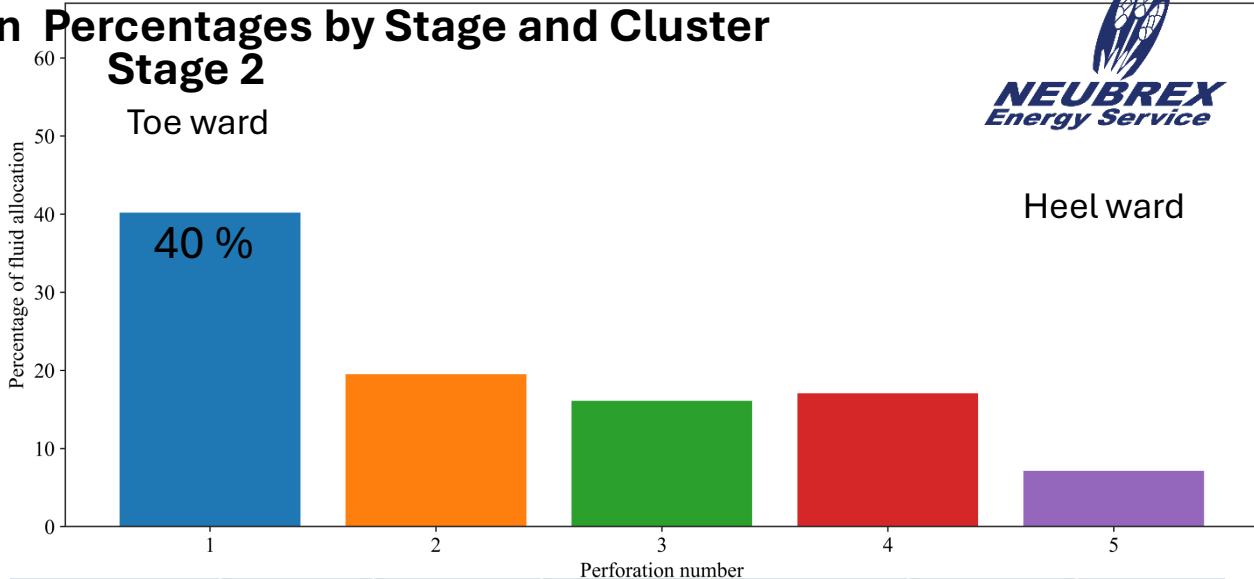
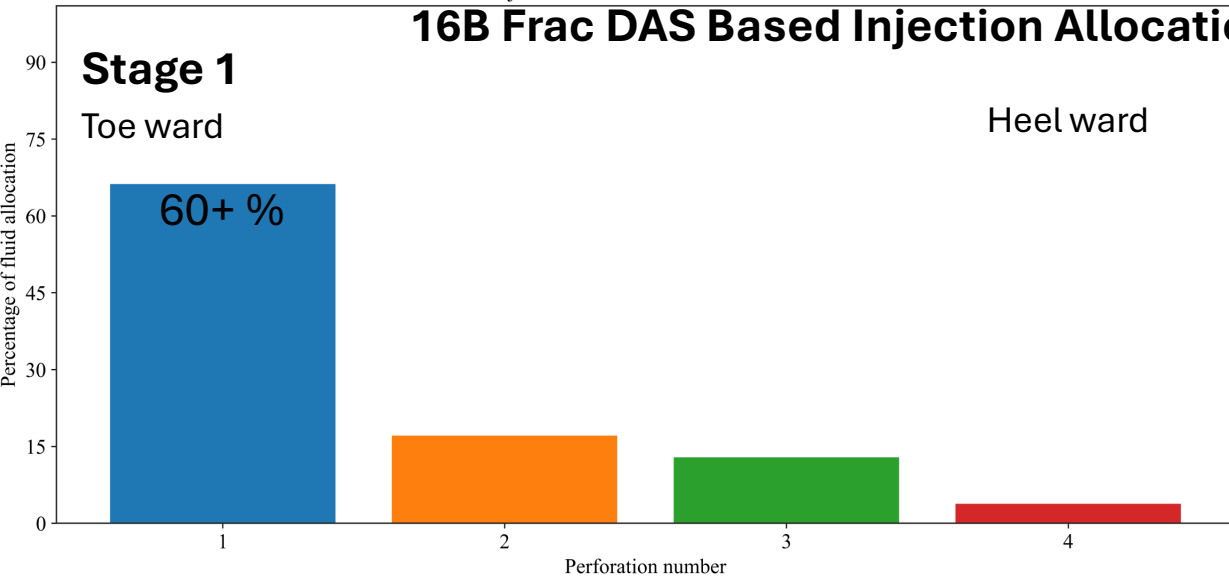
16B(78)-32 Plug and Perf Summary of Injection Efficiency & Plug Efficacy



Stage #	No. Clusters	No. Clusters Seen w DAS	Plug Detected?	Plug Slip or Poor Isolation Detect
1	4	4	Yes, clear	Yes, leakage
2	5	5	Yes, weak	No
3	3	2 (3?)	Yes, clear	Yes, clear slip
4	4	4	Yes, clear	Yes, leakage

Fluid injection allocation for band: 512-2048 Hz

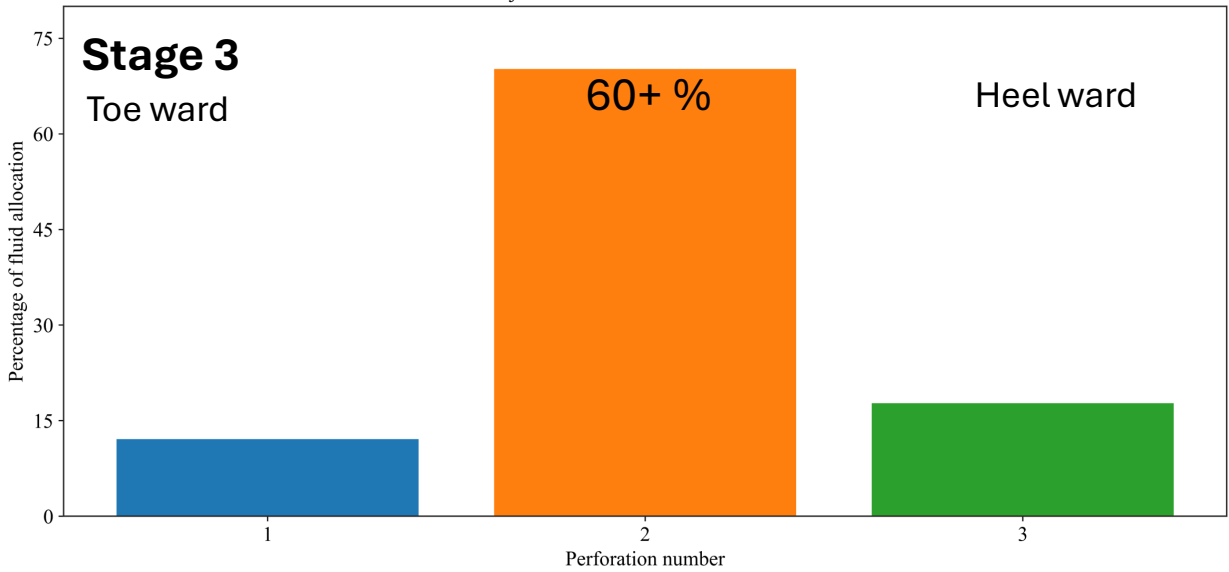
16B Frac DAS Based Injection Allocation Percentages by Stage and Cluster



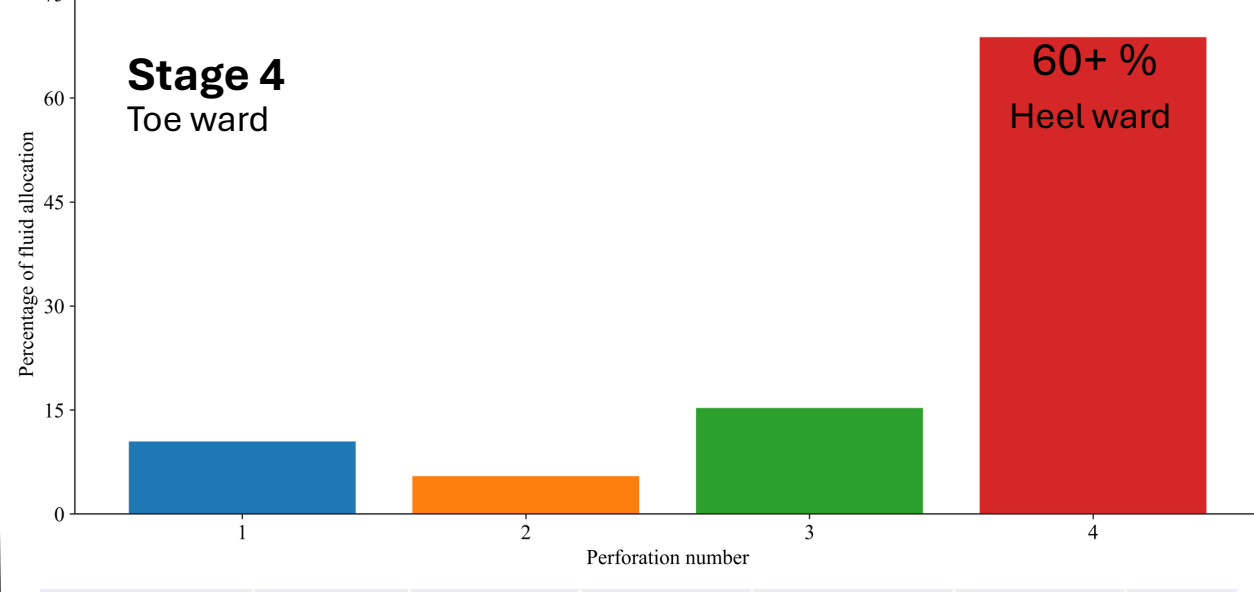
Stage 1	4	Slickwater	3,624	60 (Avg = 55)	45,600	66,840
Stage Name	Number of Clusters	Fluid Type	Fluid Volume (bbl)	Pump Rate (bpm)	100-mesh Prop Volume (lb _m)	40/70-mesh Prop Volume (lb _m)

Stage 2	5	Slickwater	4,734	60 (Avg = 56)	46,770	102,000
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Fluid injection allocation for band: 512-2048 Hz



Fluid injection allocation for band: 512-2048 Hz

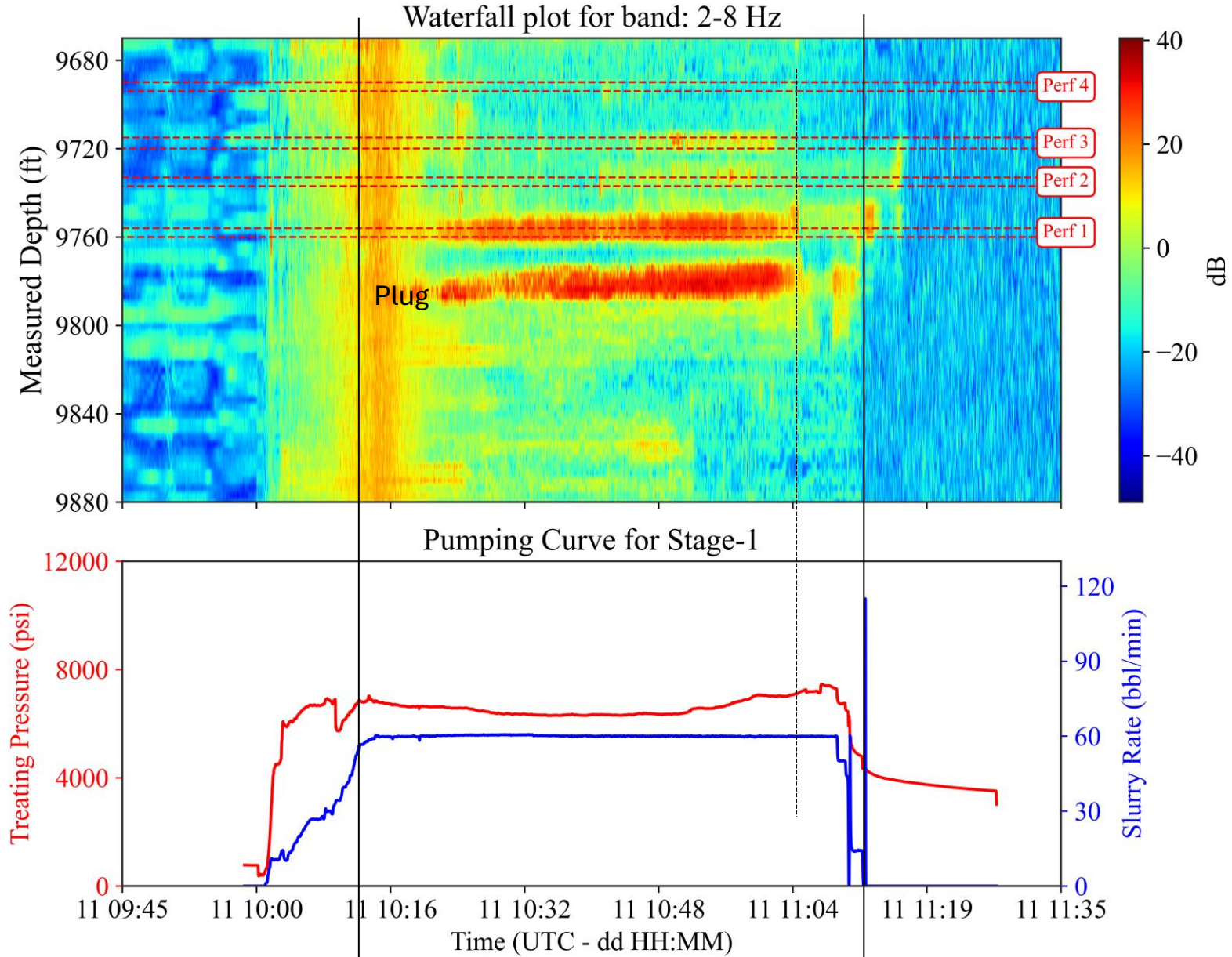


Stage 3	3	Slickwater	4,321	60 (Avg = 51)	43,322	70,163
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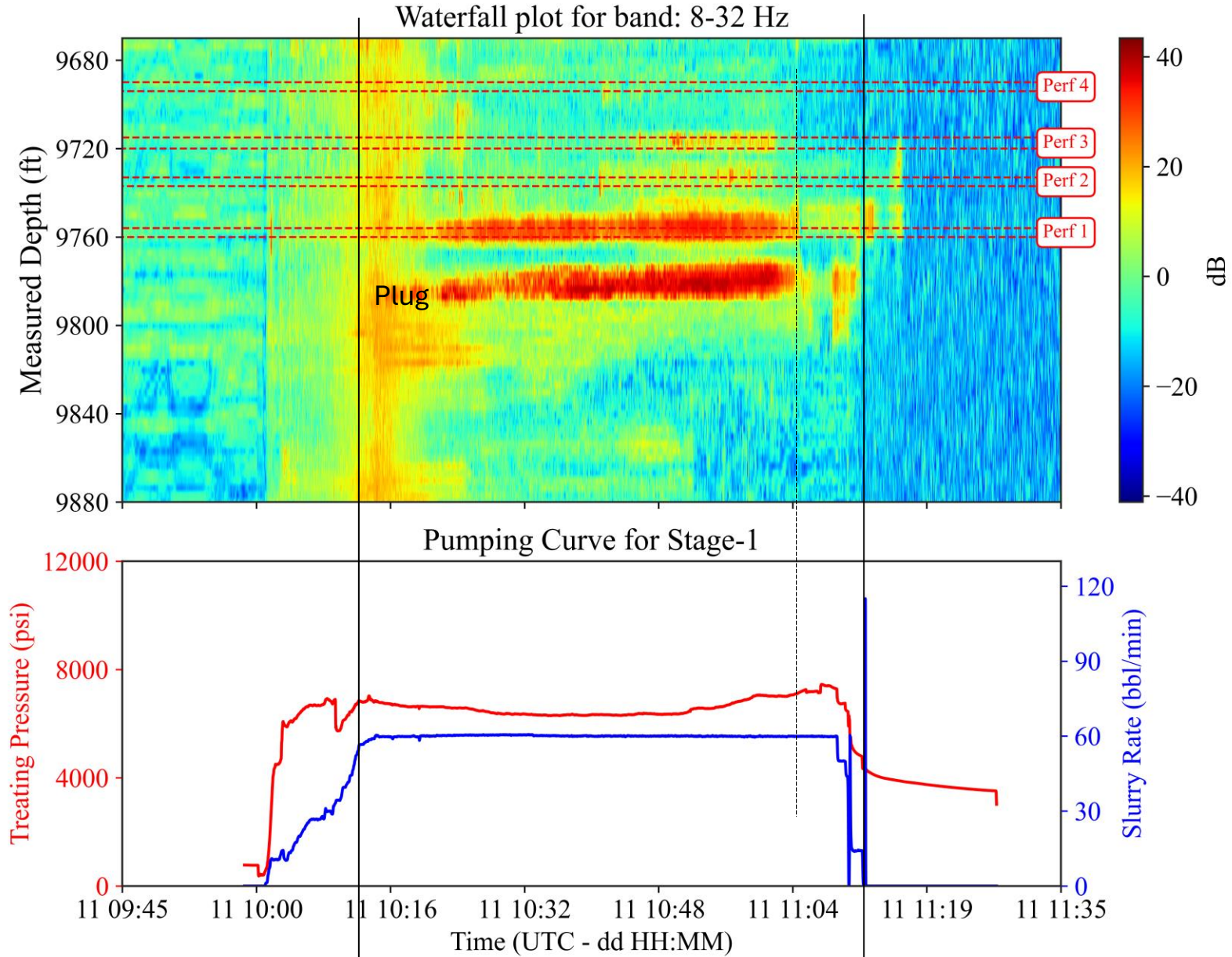
Stage 4	4	Slickwater	3,800	60 (Avg = 56)	43,217	65,317
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Stage 1: Apr 11, 10:01-11:12 (UTC Time)
Frequency Band Energy (FBE) Extractions
Bands along with Pumping Curves

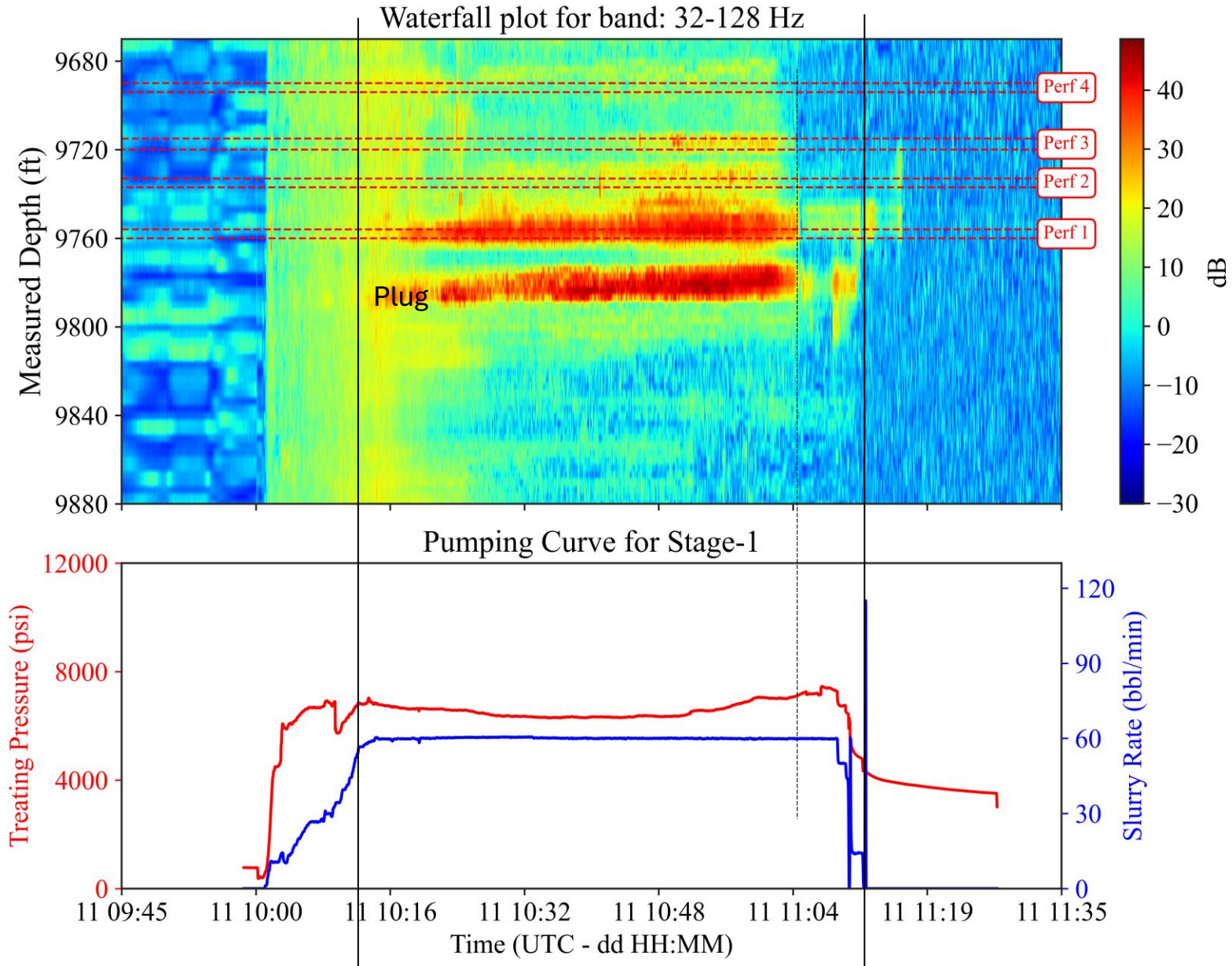
Stage 1: 2-8 Hz



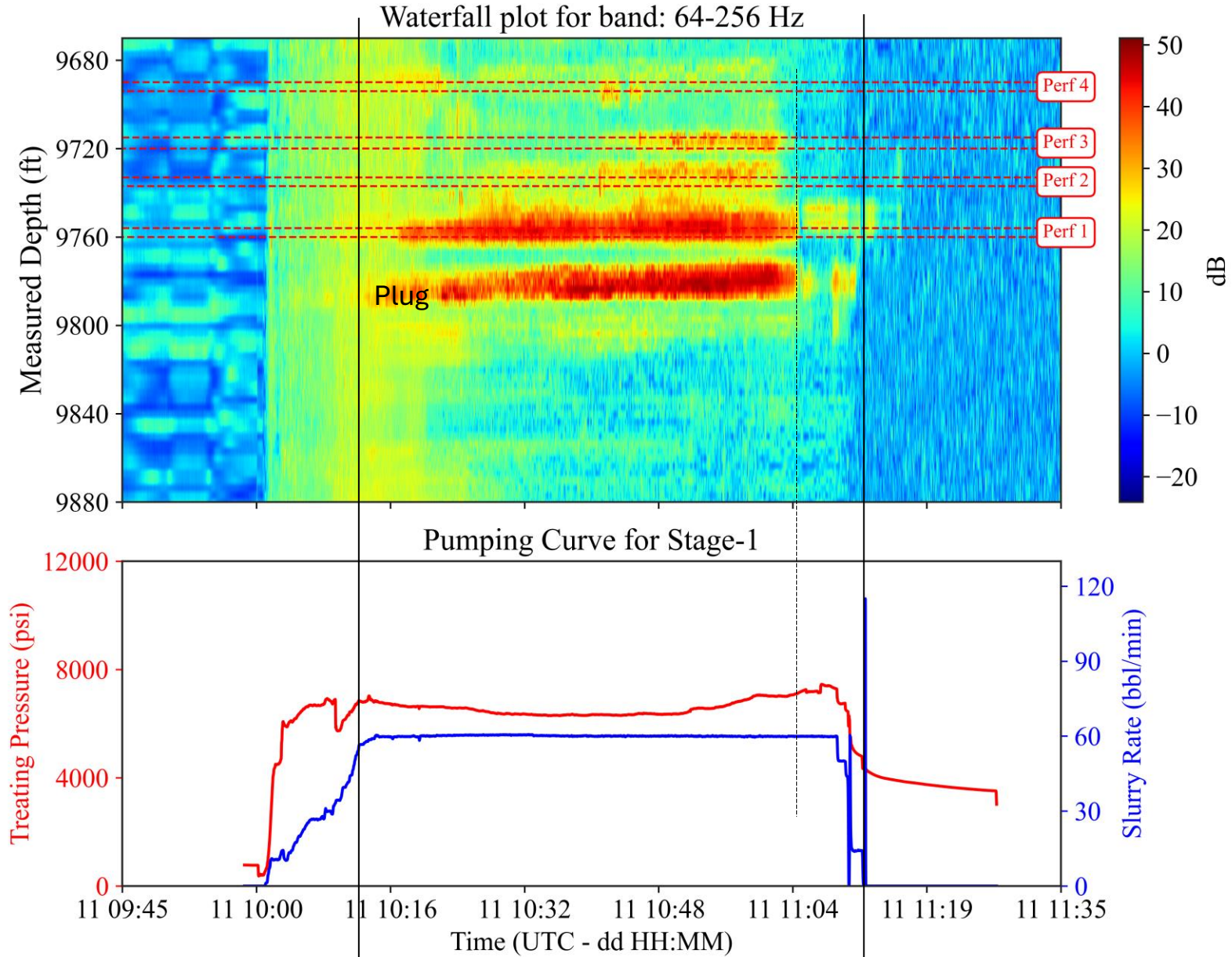
Stage 1: 8-32 Hz



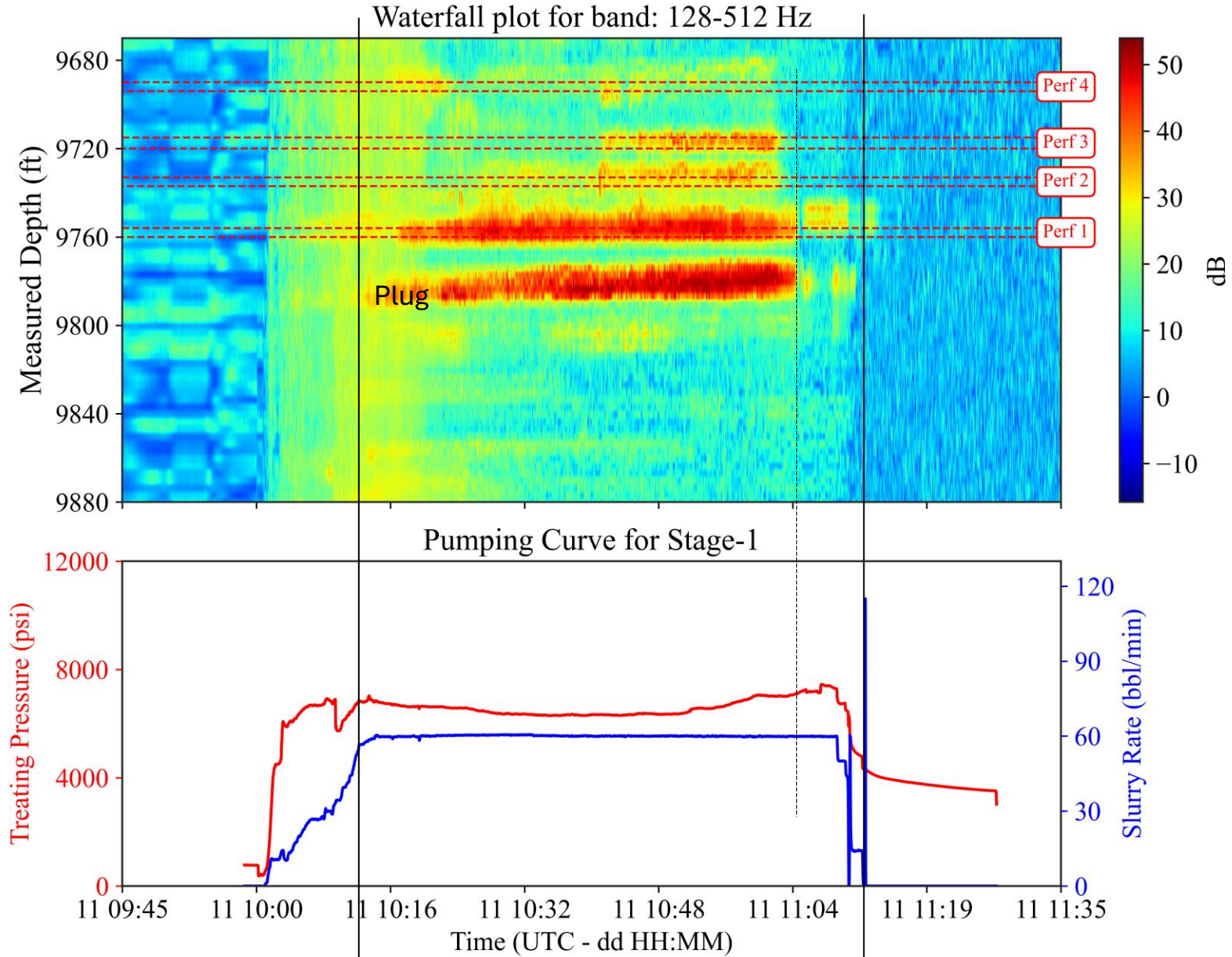
Stage 1: 32-128 Hz



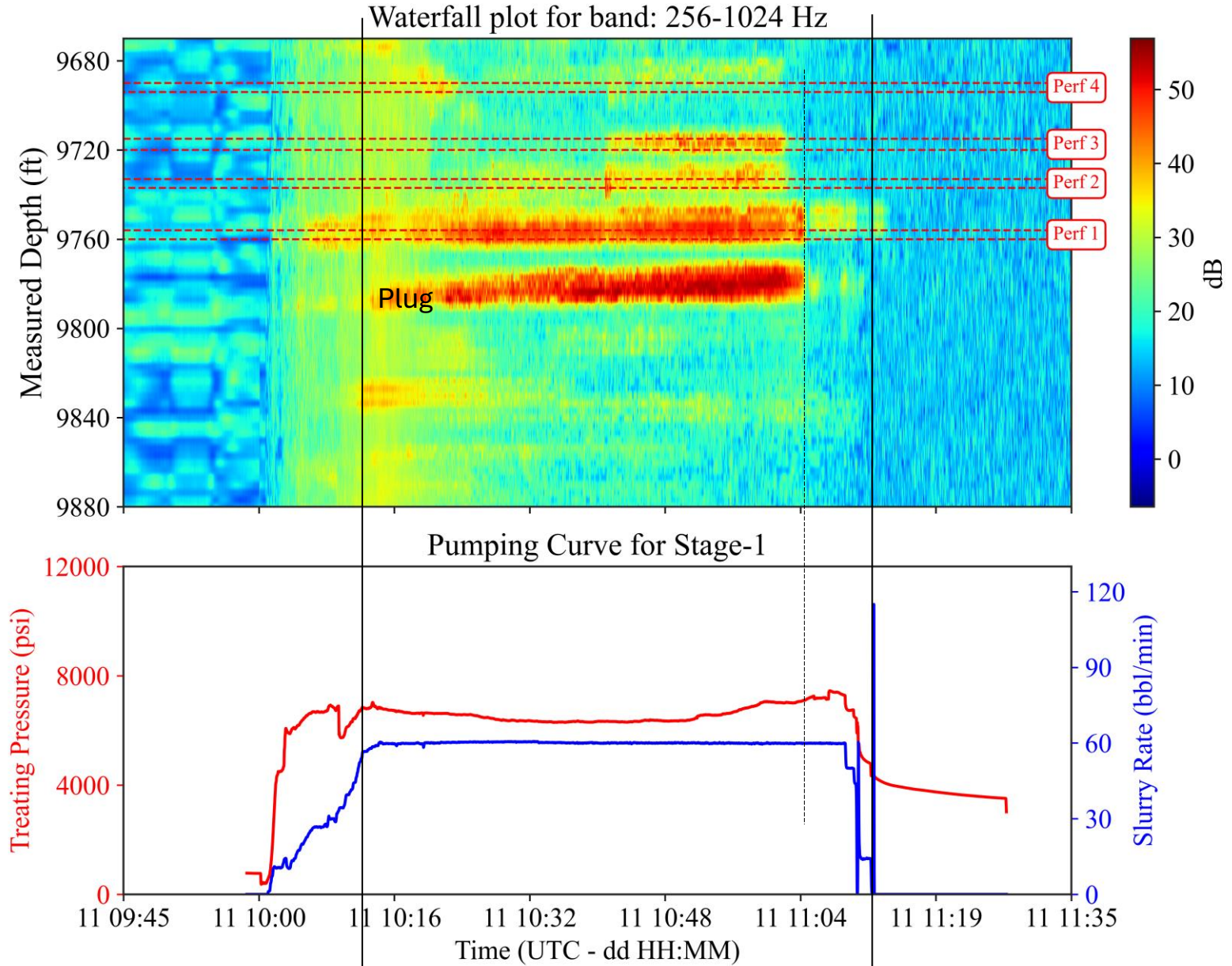
Stage 1: 64-256 Hz



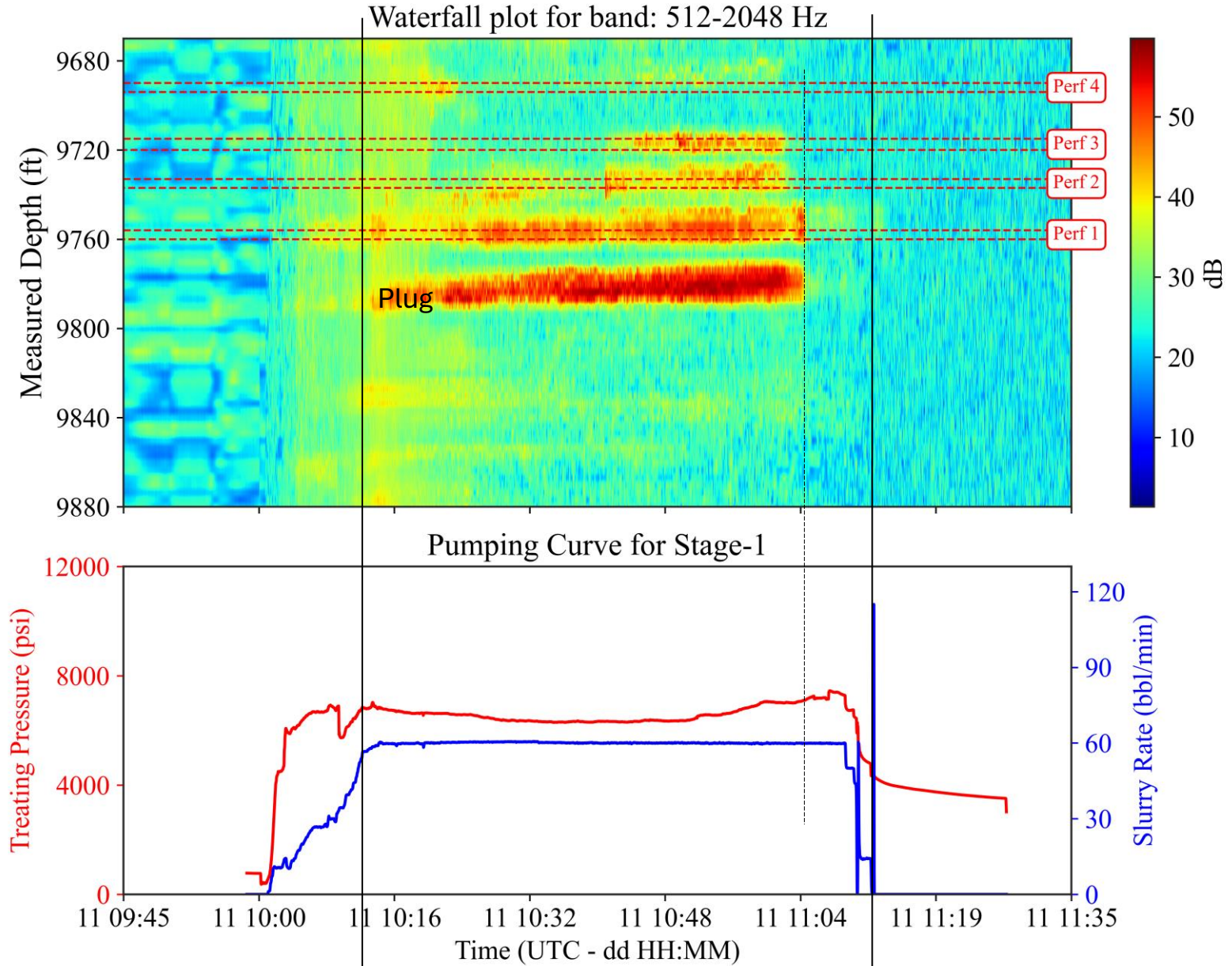
Stage 1: 128-512 Hz



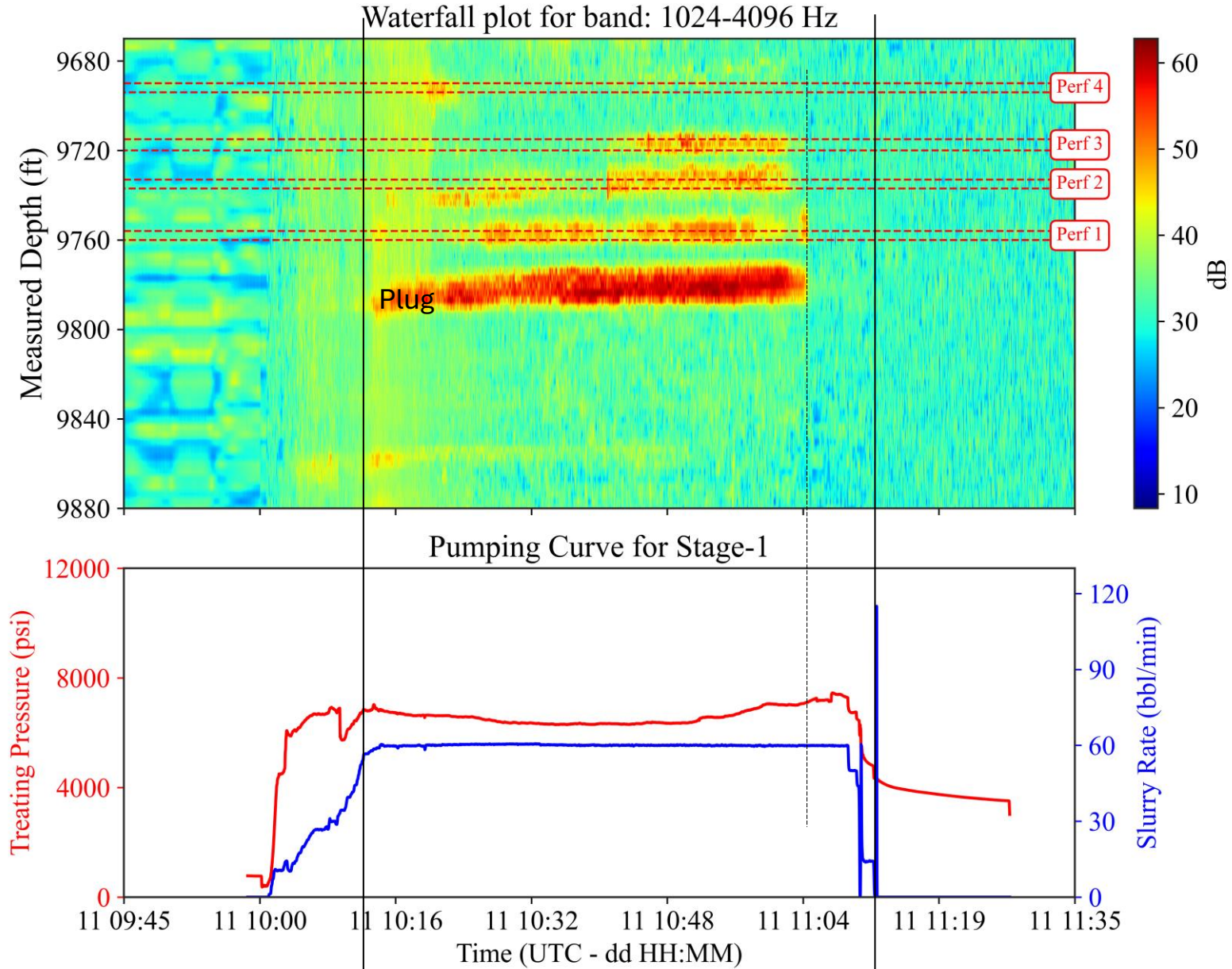
Stage 1: 256-1024 Hz



Stage 1: 512-2048 Hz



Stage 1: 1024-4096 Hz

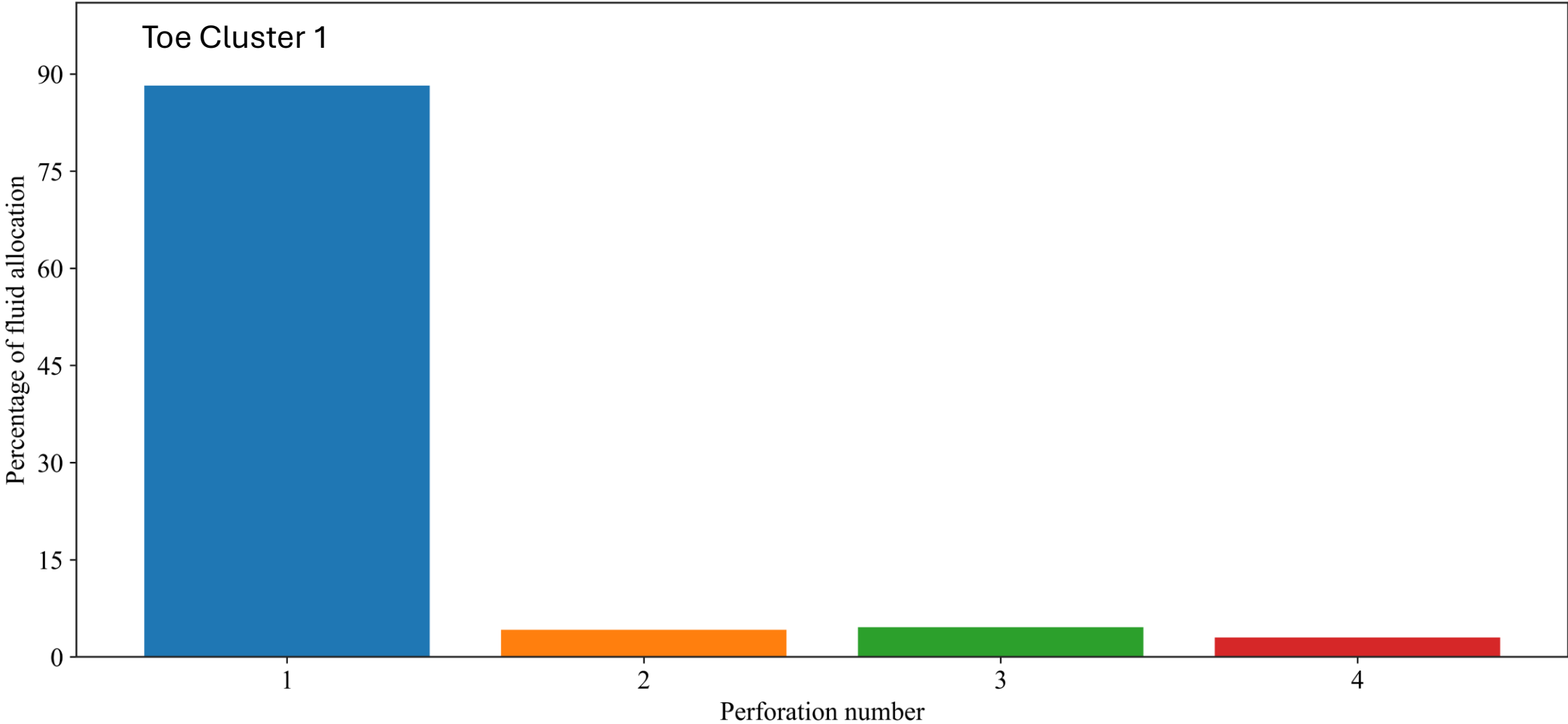


Stage 1: Apr 11, 10:01-11:12 (UTC Time) Injection Allocation Calculation Results

Stage 1: 2-8 Hz



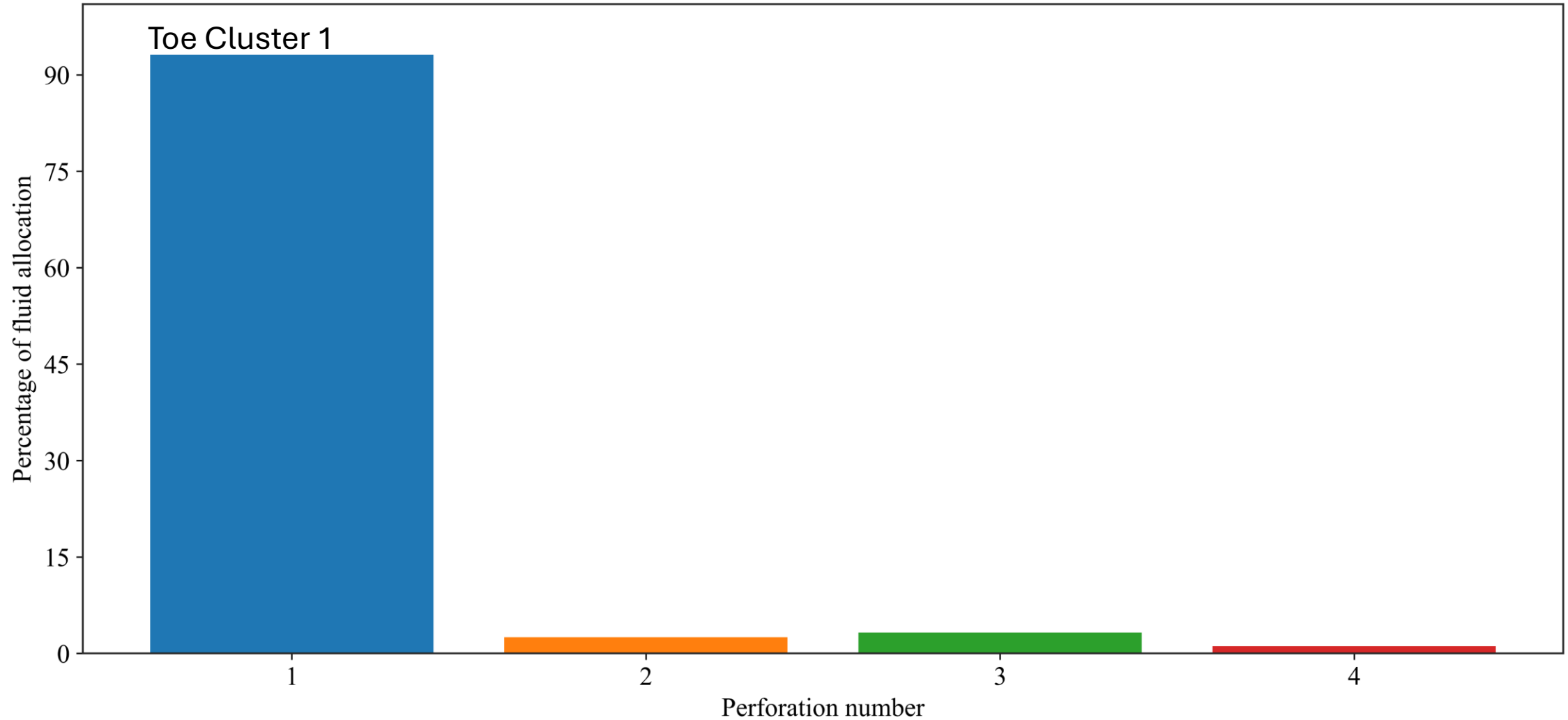
Fluid injection allocation for band: 2-8 Hz



Stage 1: 8-32 Hz



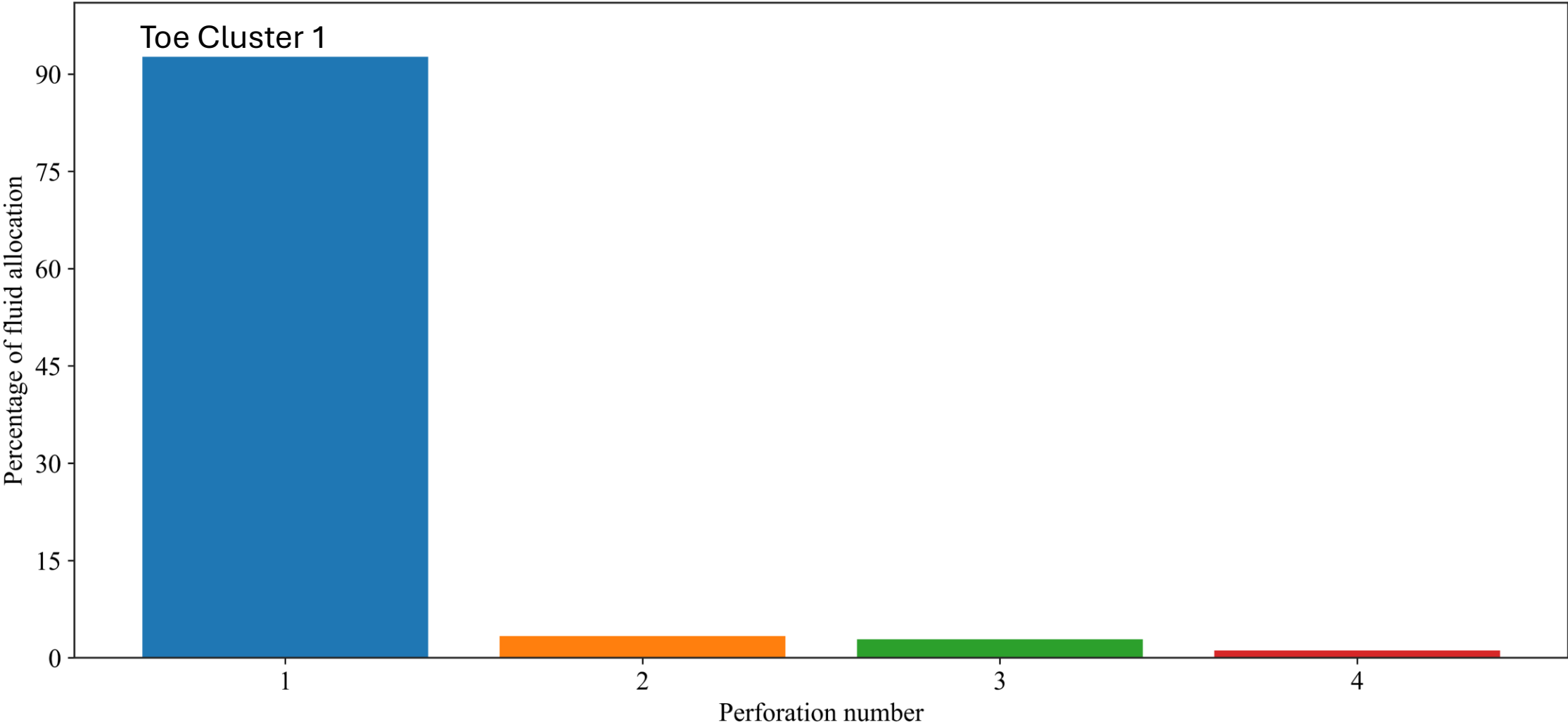
Fluid injection allocation for band: 8-32 Hz



Stage 1: 32-128 Hz



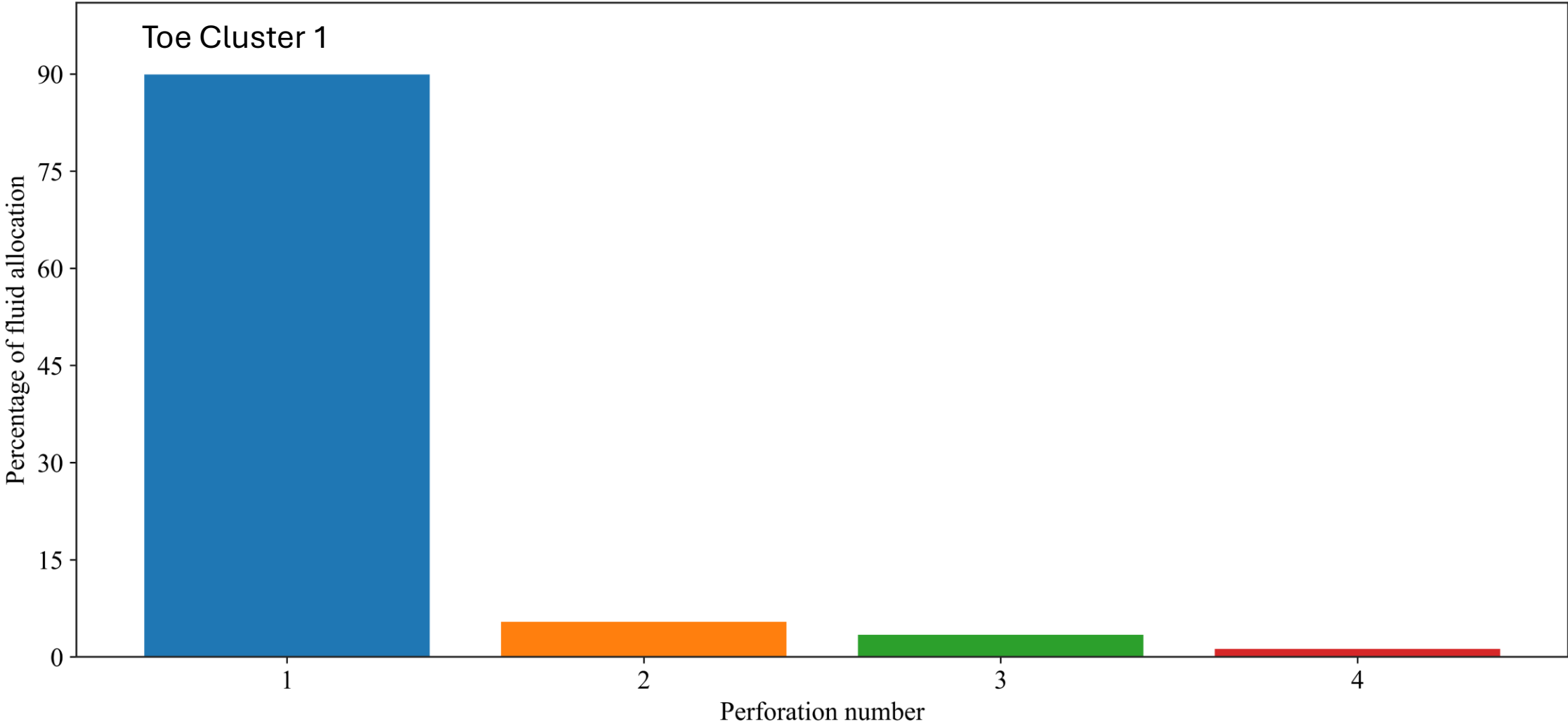
Fluid injection allocation for band: 32-128 Hz



Stage 1: 64-256 Hz



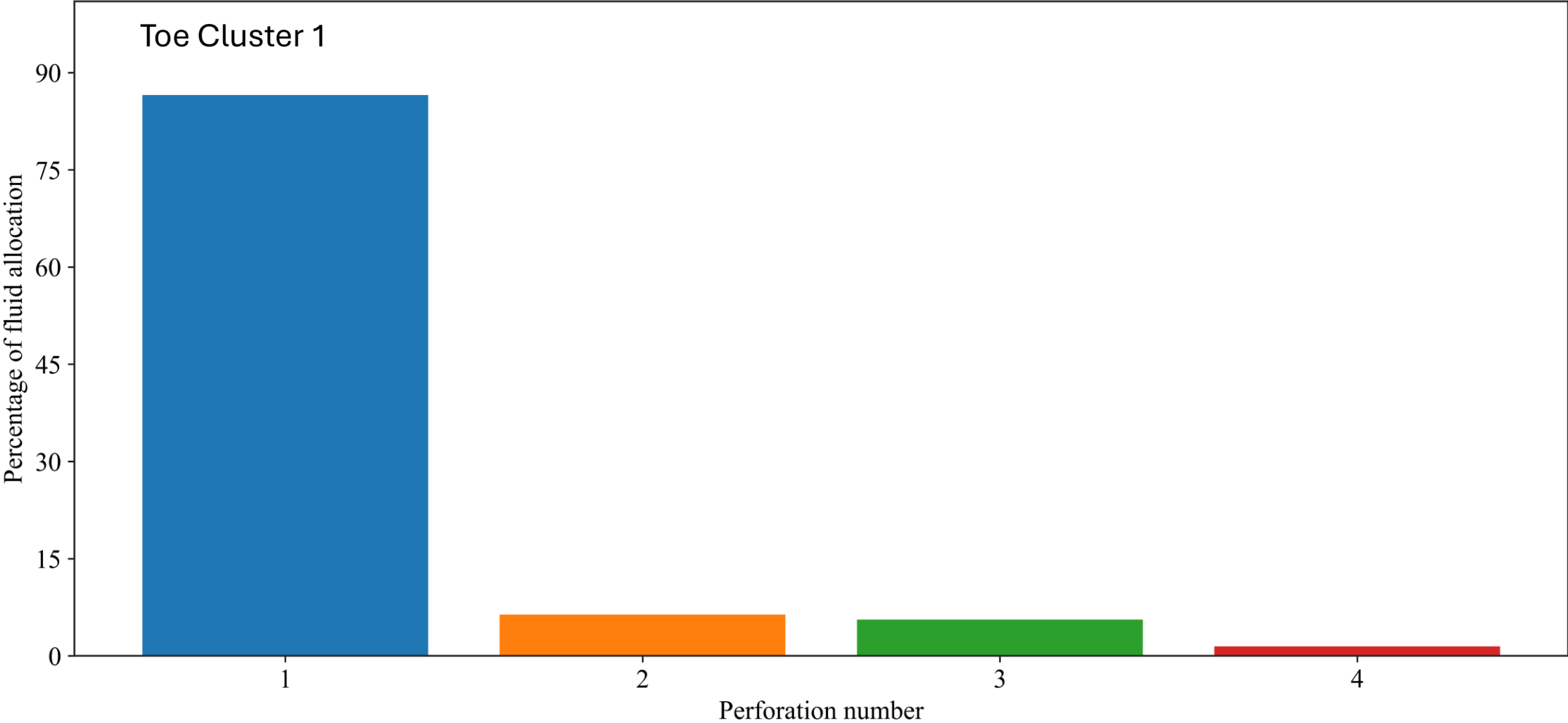
Fluid injection allocation for band: 64-256 Hz



Stage 1: 128-512 Hz



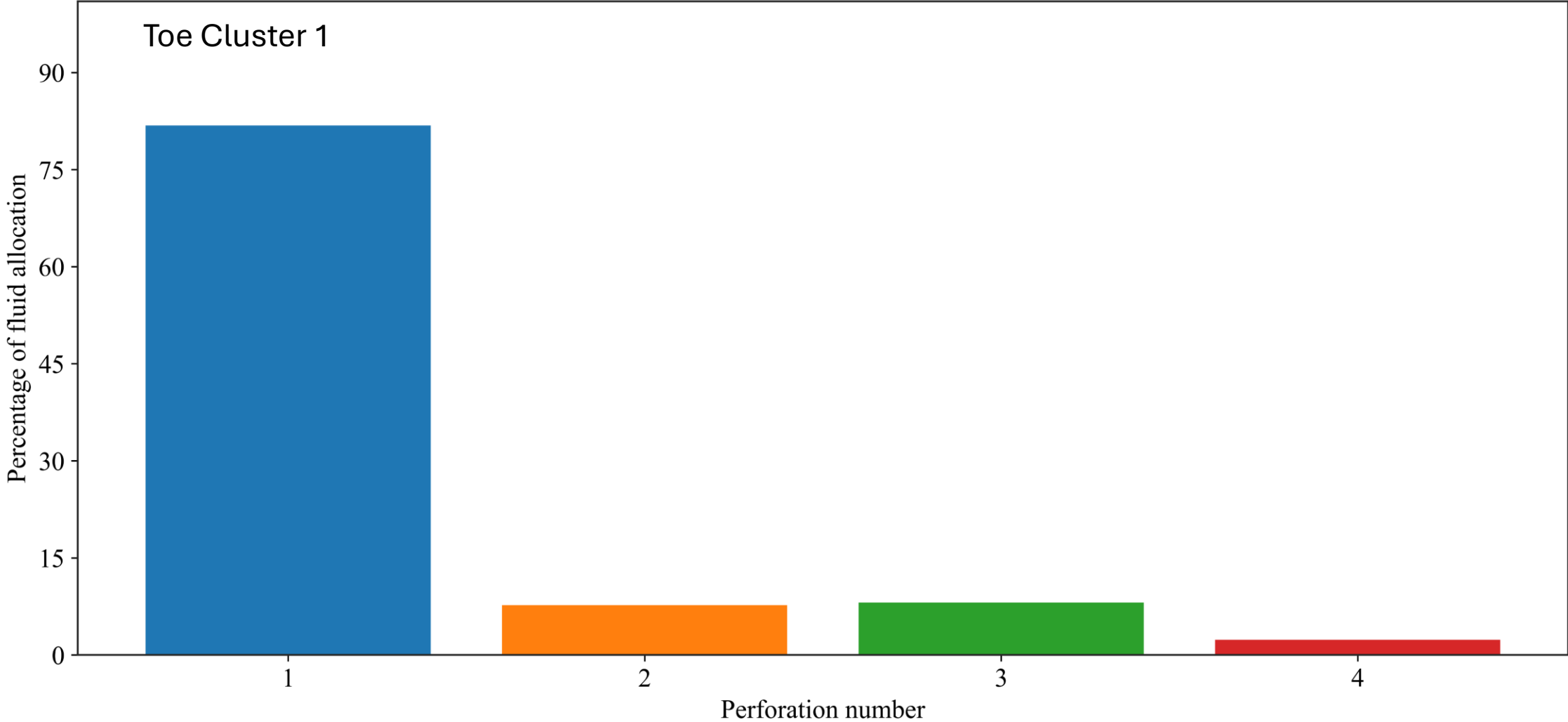
Fluid injection allocation for band: 128-512 Hz



Stage 1: 256-1024 Hz



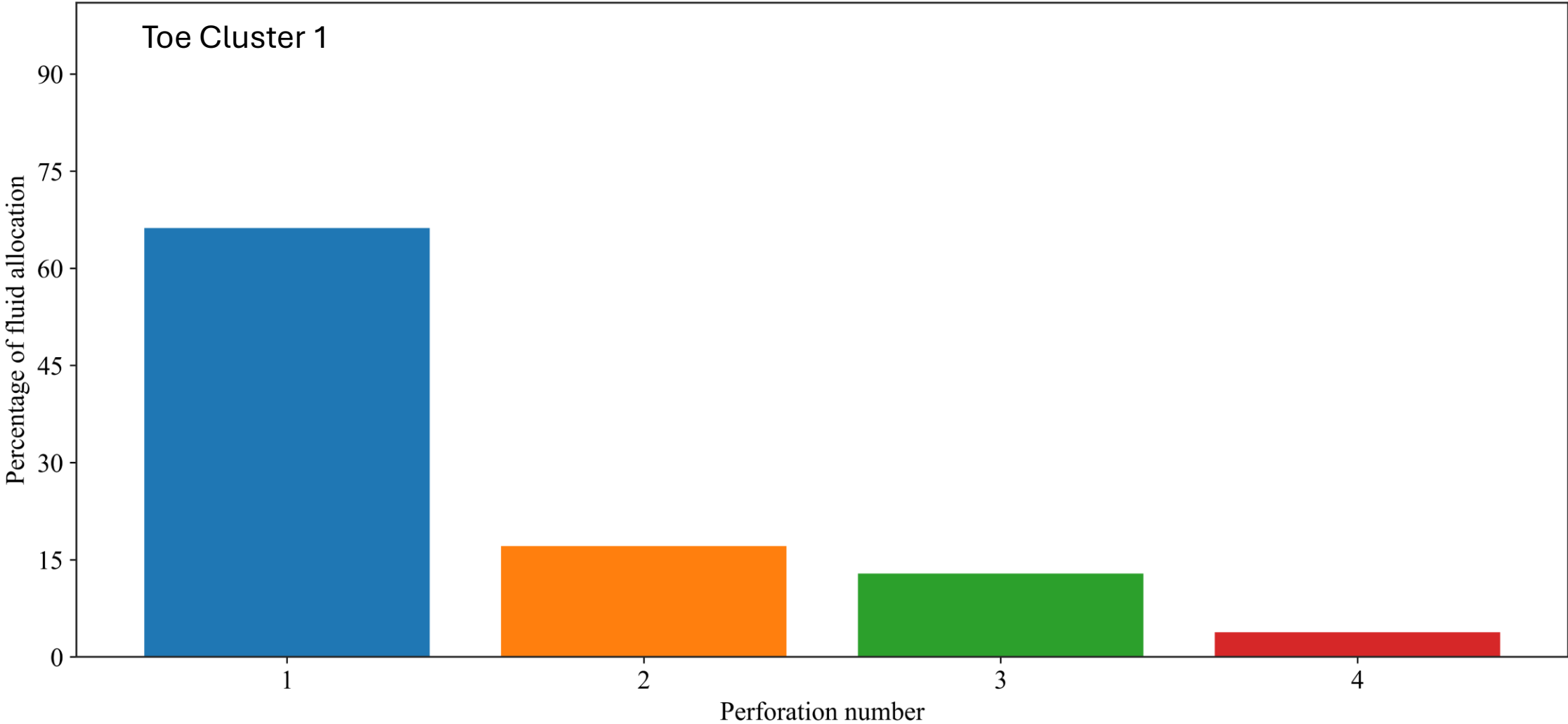
Fluid injection allocation for band: 256-1024 Hz



Stage 1: 512-2048 Hz



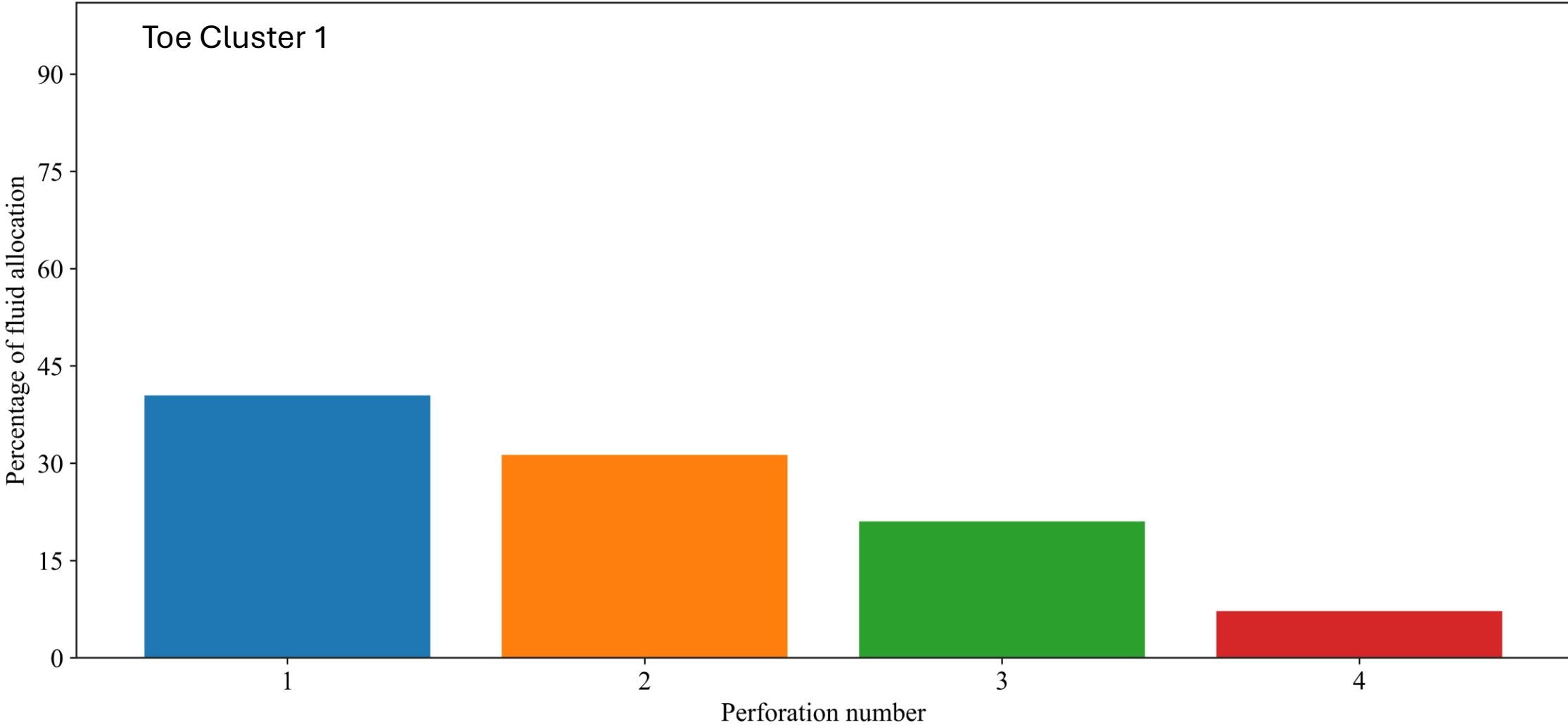
Fluid injection allocation for band: 512-2048 Hz



Stage 1: 1024-4096 Hz

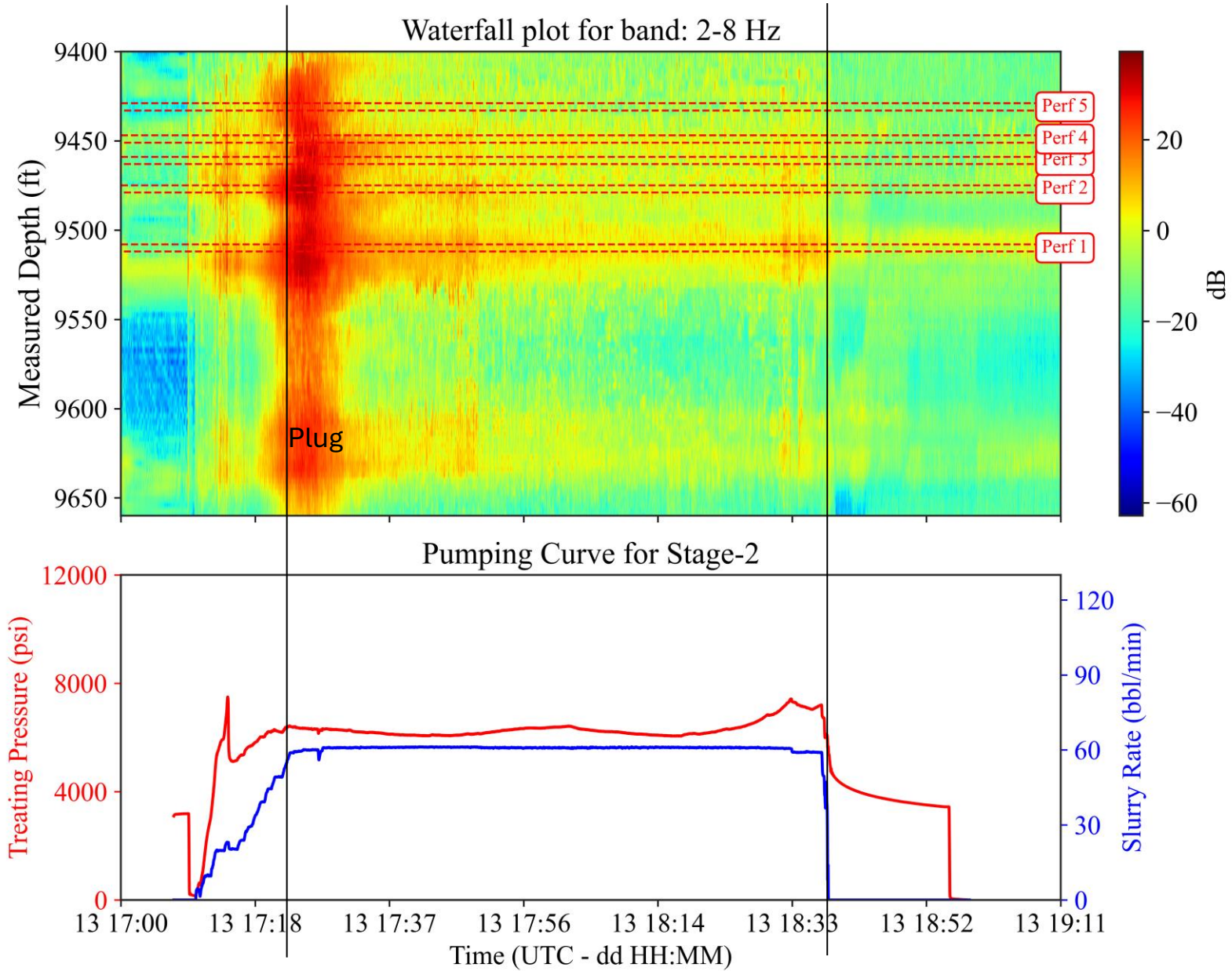


Fluid injection allocation for band: 1024-4096 Hz

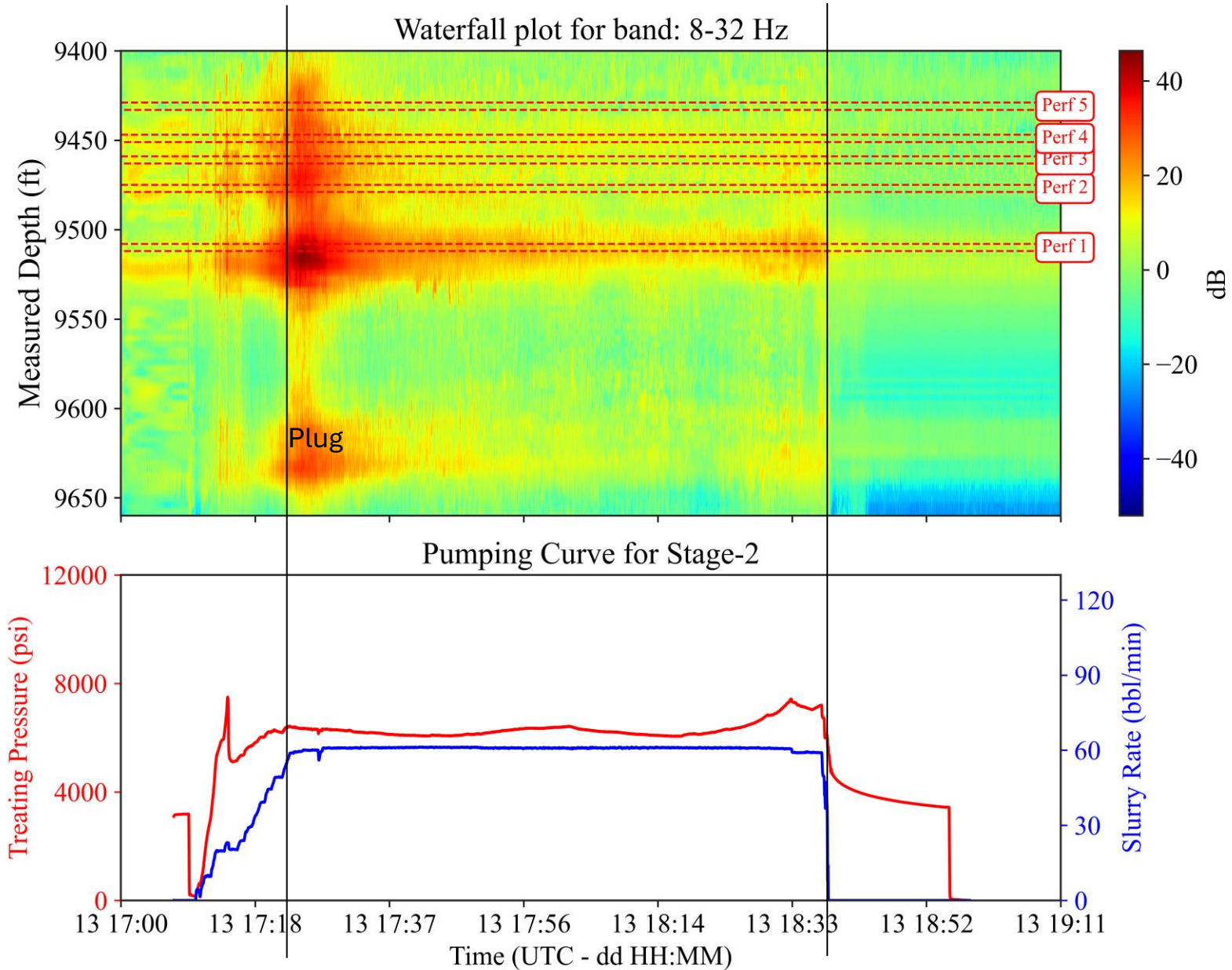


Stage 2: Apr 11, 17:10-18:38 (UTC Time)
Frequency Band Energy (FBE) Extractions
FBE Bands along with Pumping Curves

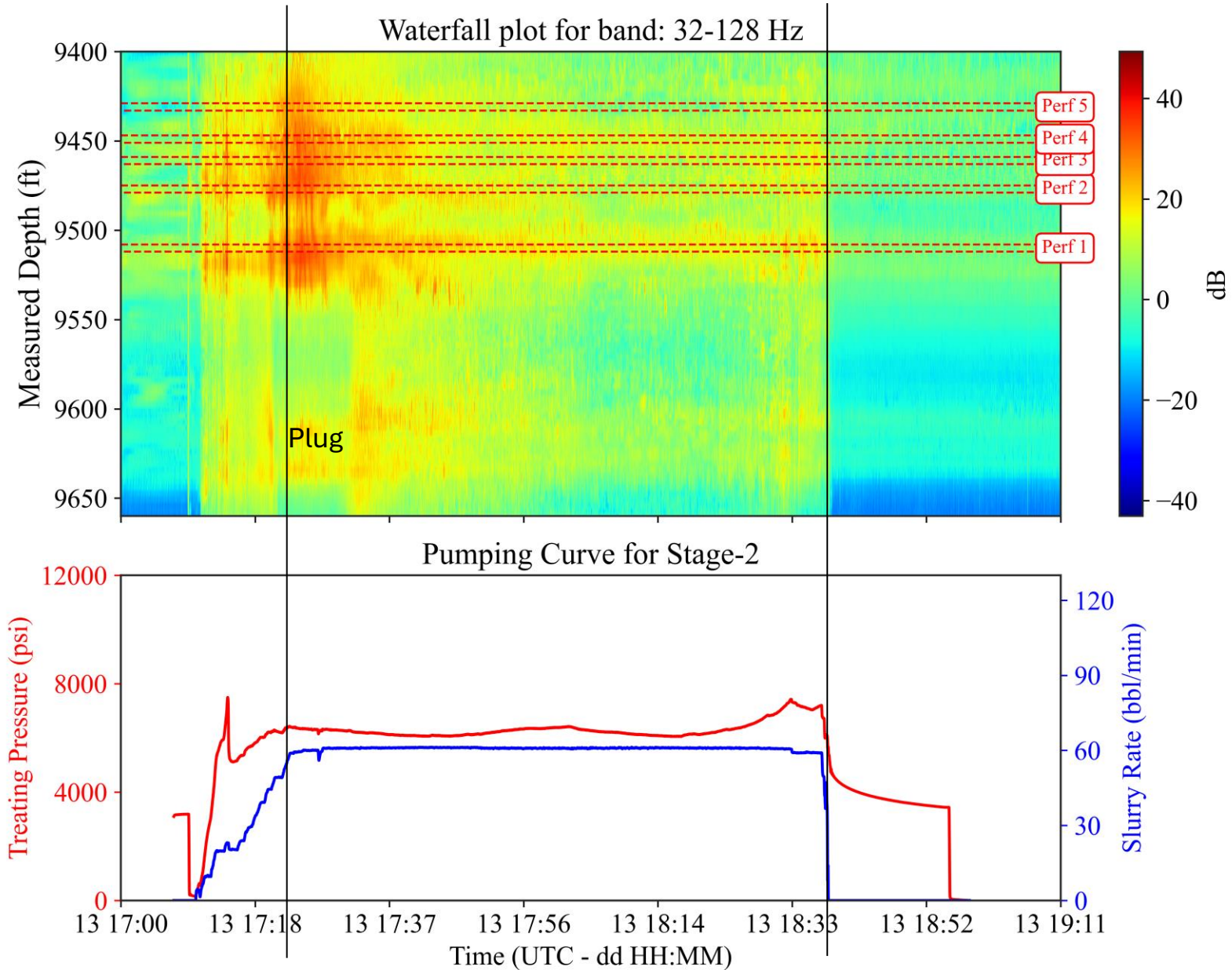
Stage 2: 2-8 Hz



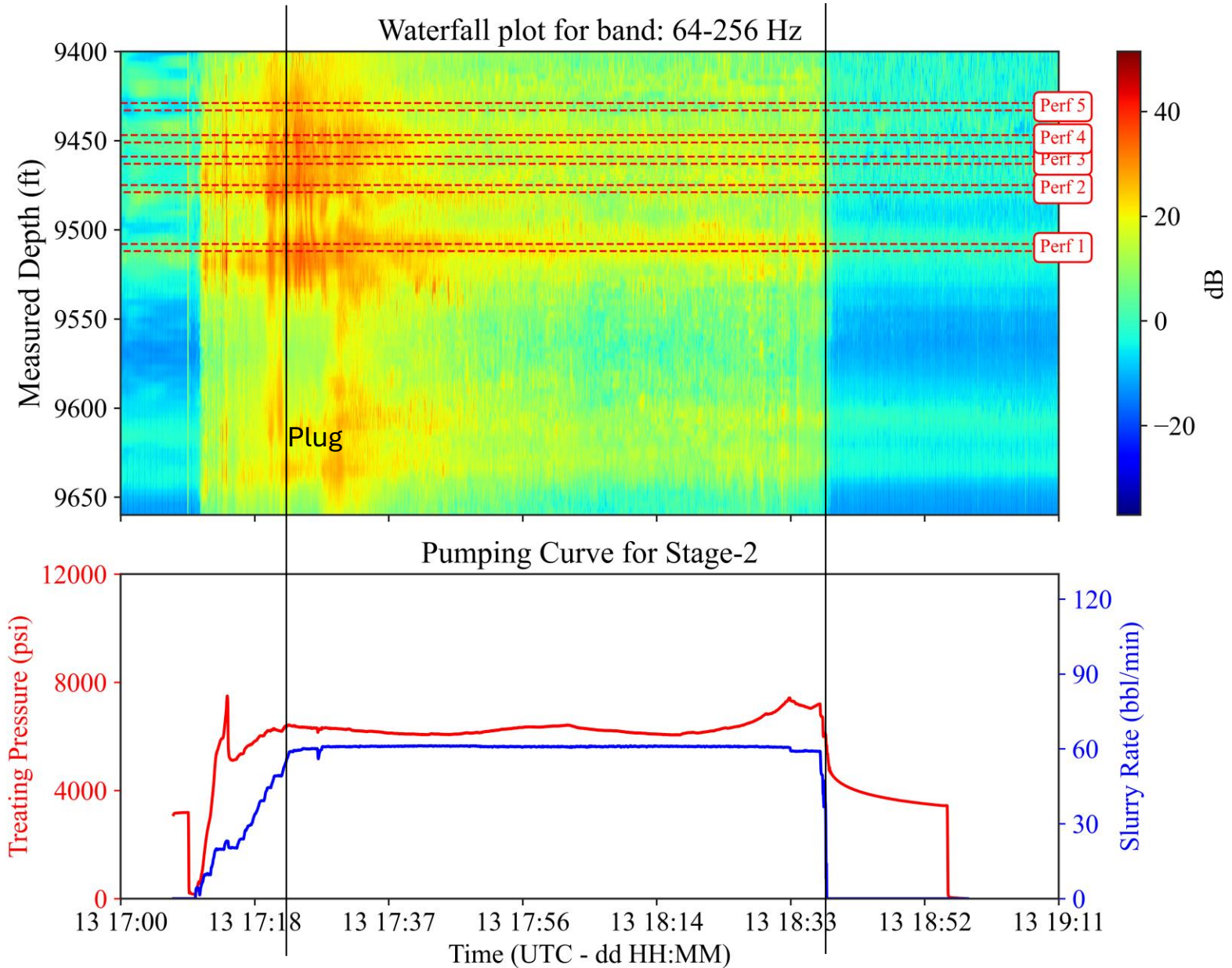
Stage 2: 8-32 Hz



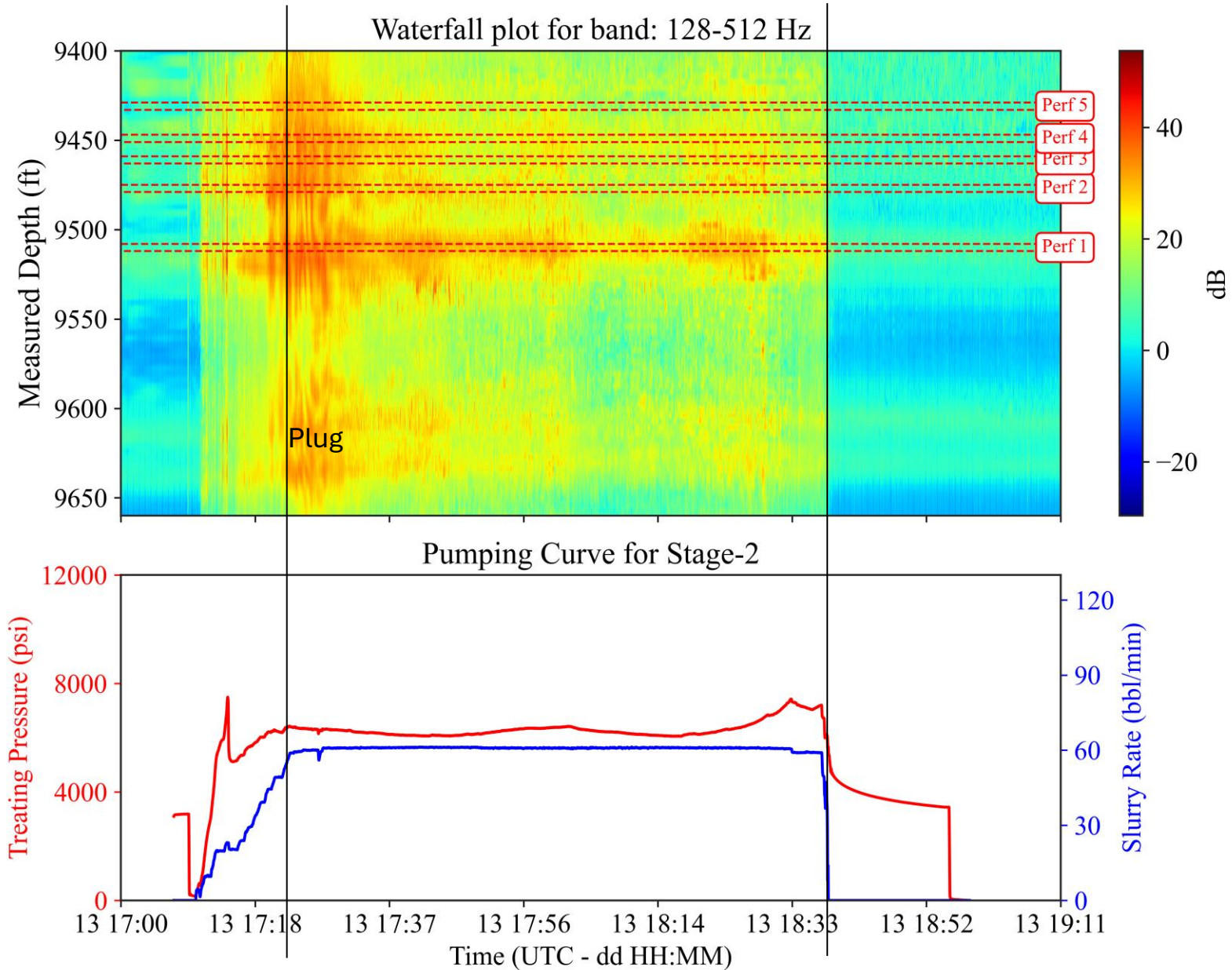
Stage 2: 32-128 Hz



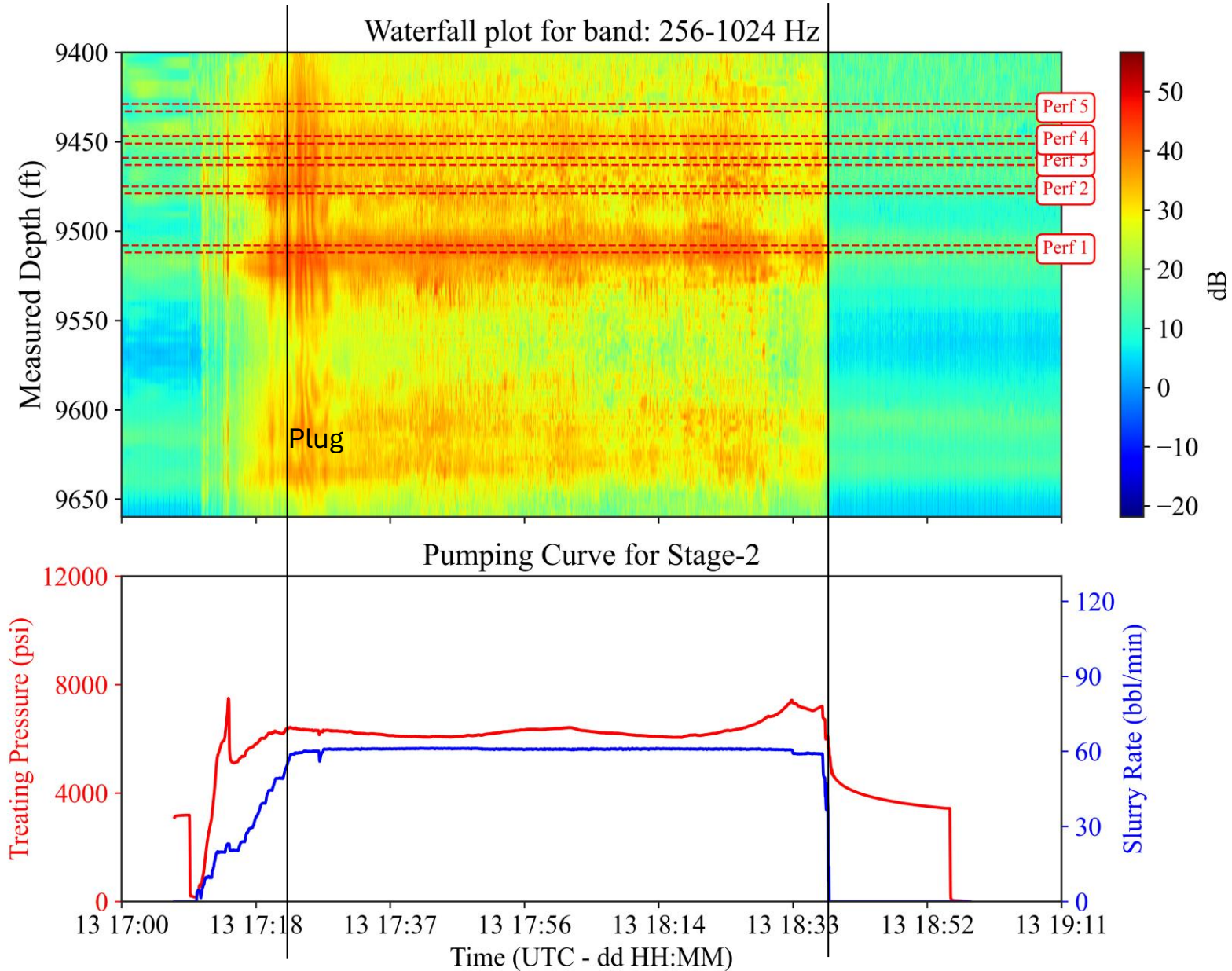
Stage 2: 64-256 Hz



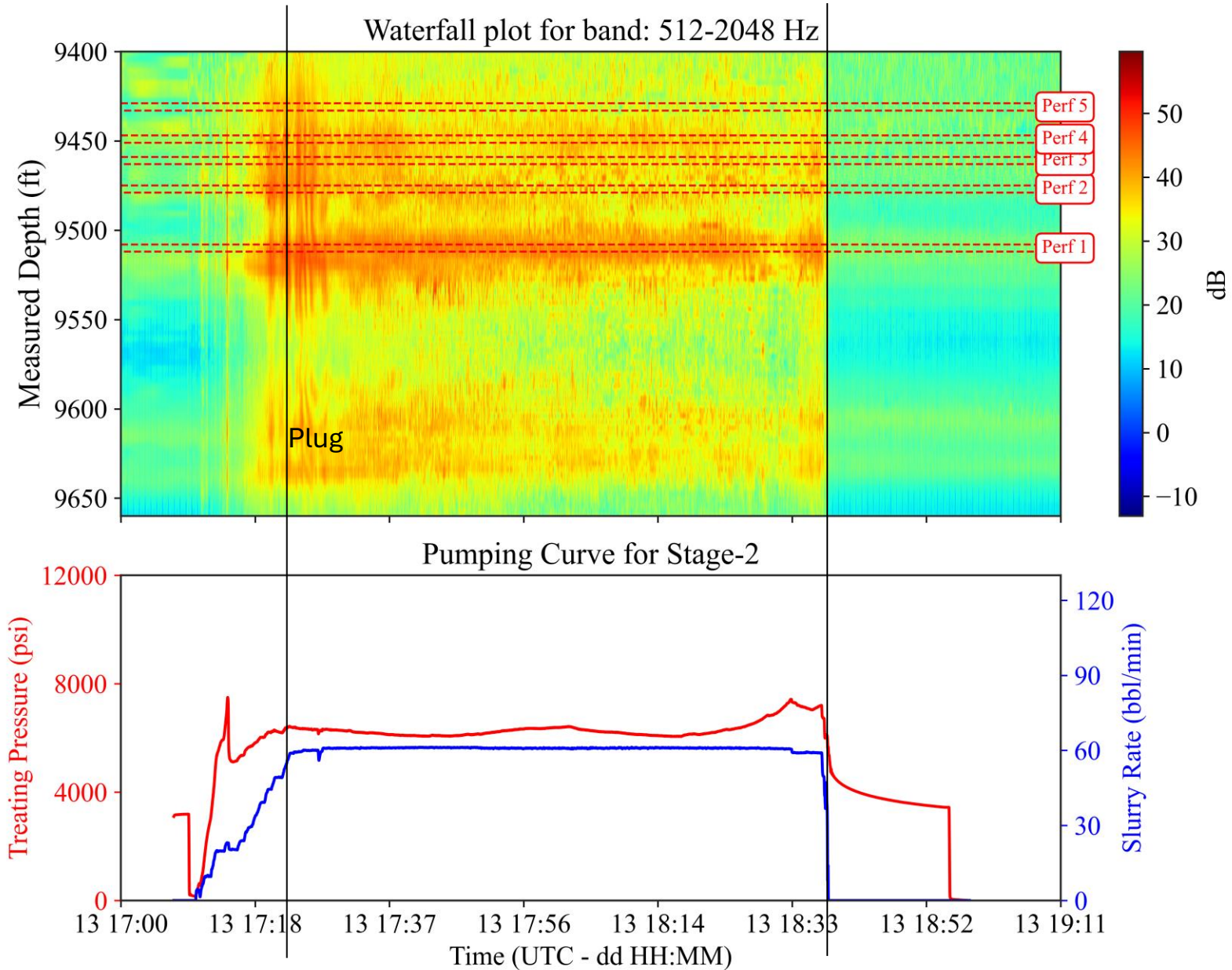
Stage 2: 128-512 Hz



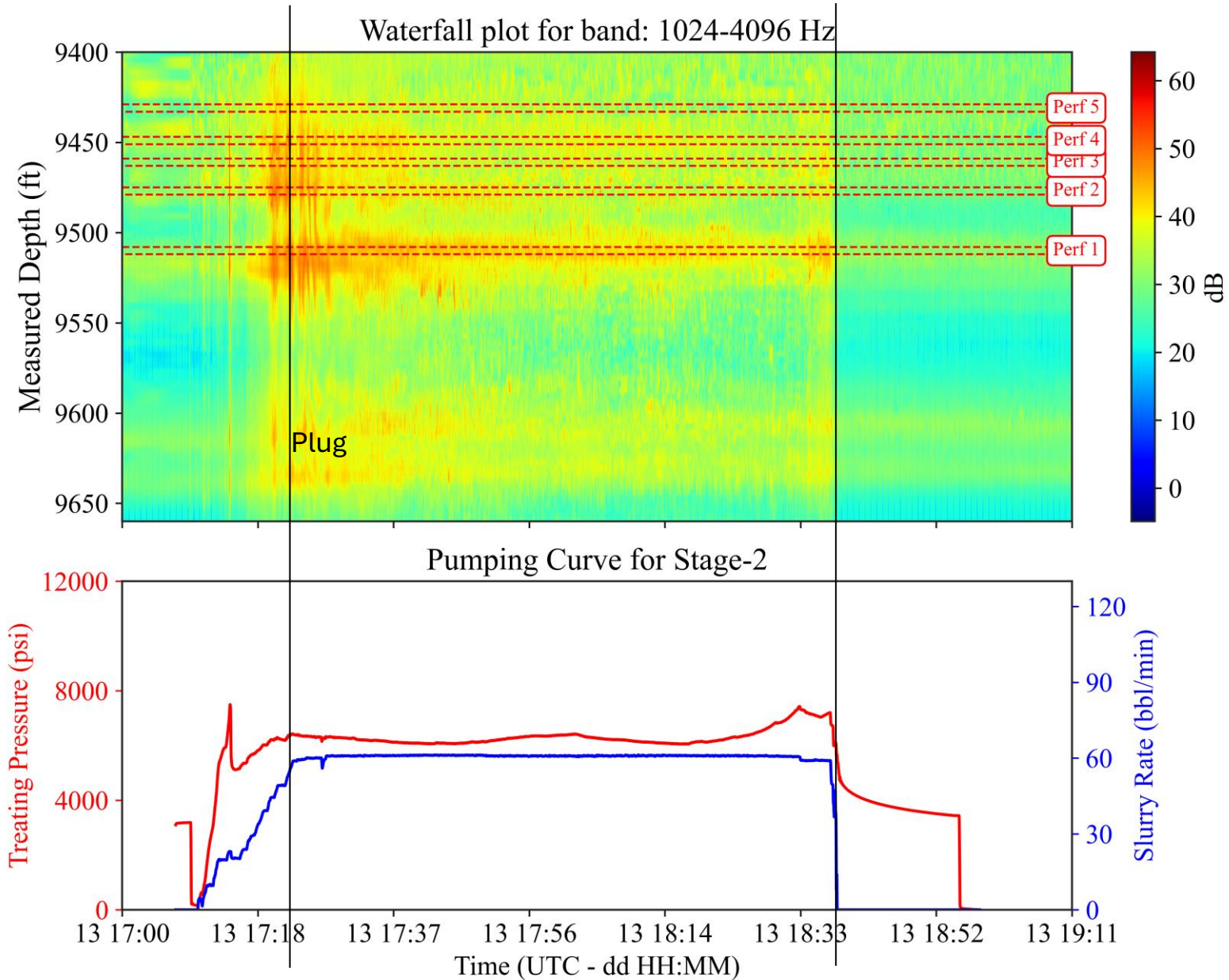
Stage 2: 256-1024 Hz



Stage 2: 512-2048 Hz



Stage 2: 1024-4096 Hz



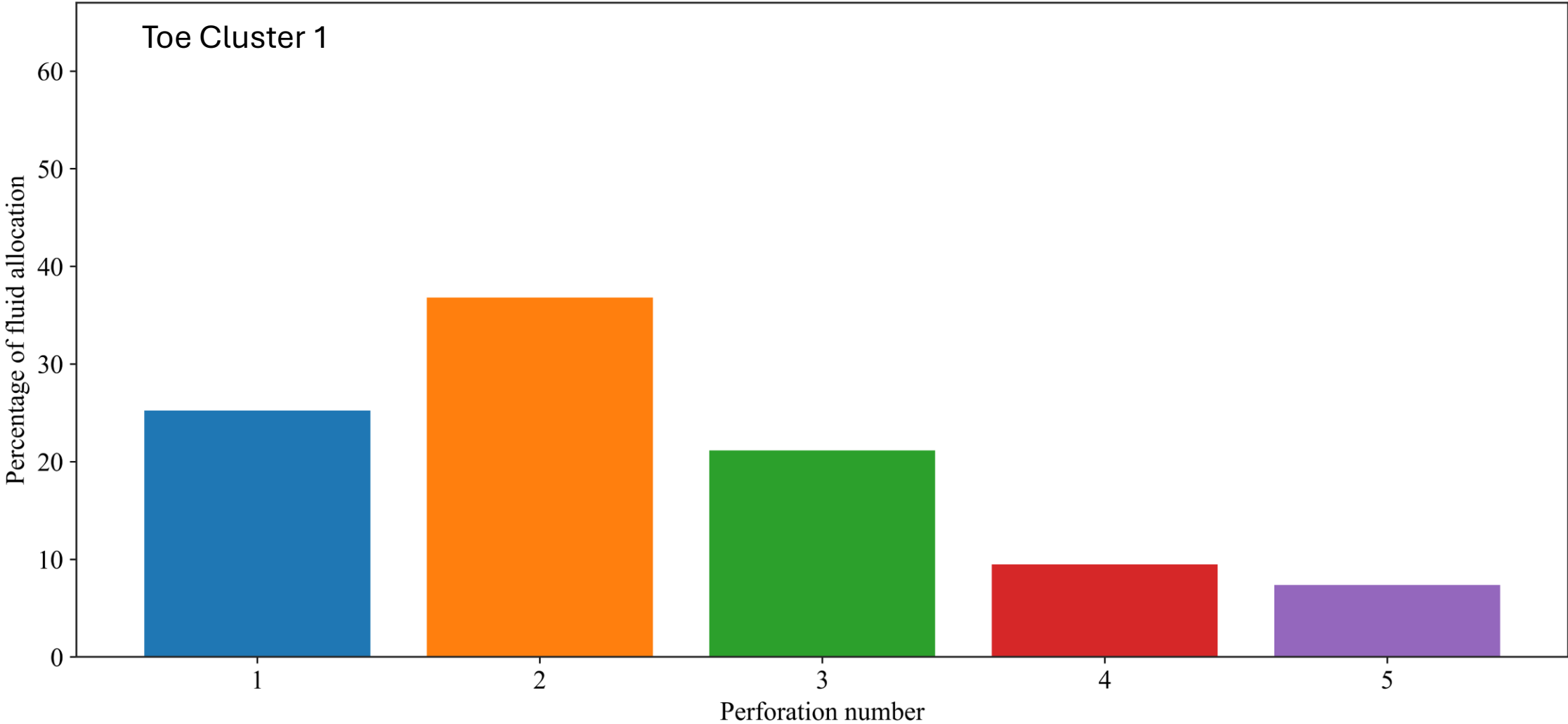
Stage 2: Apr 11, 17:10-18:38 (UTC Time)

Injection Allocation Plots

Stage 2: 2-8 Hz



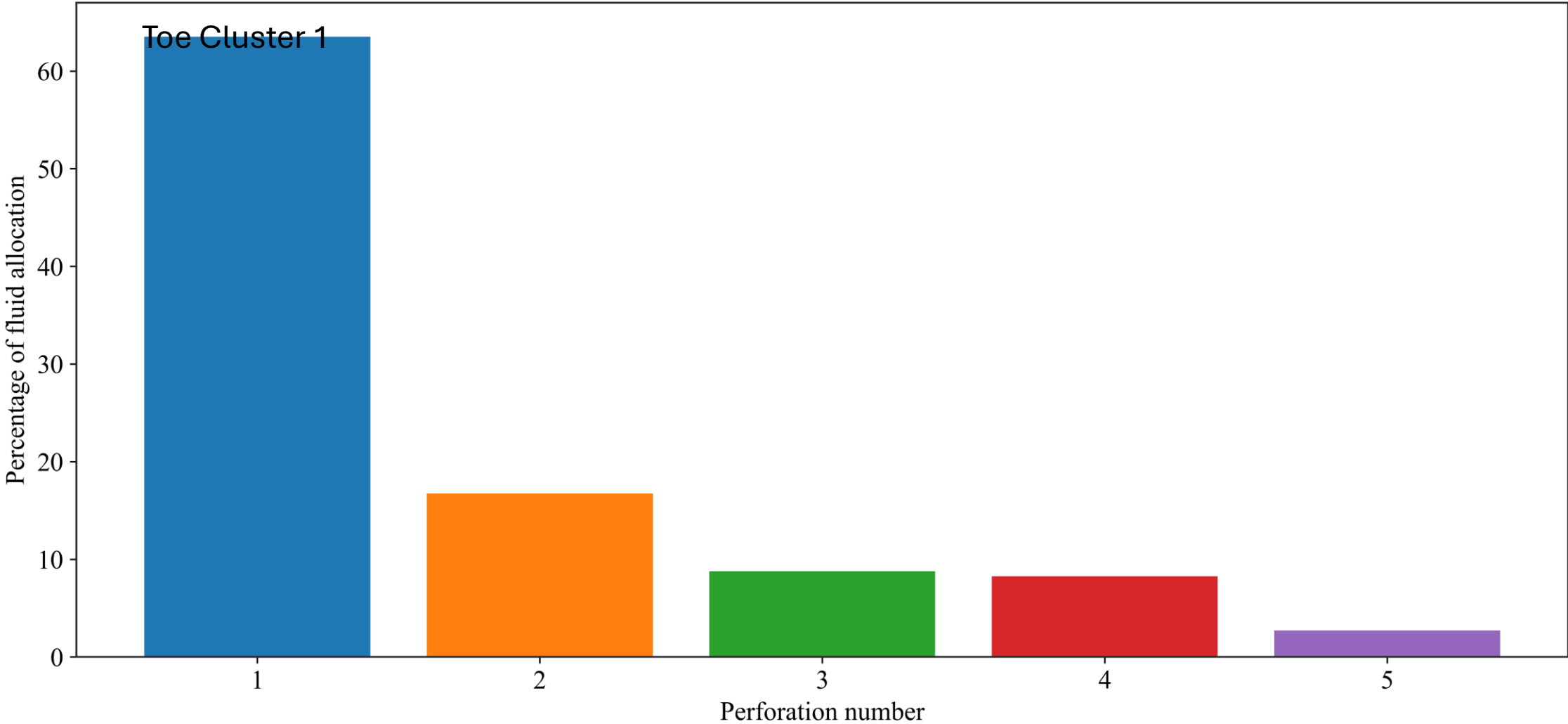
Fluid injection allocation for band: 2-8 Hz



Stage 2: 8-32 Hz



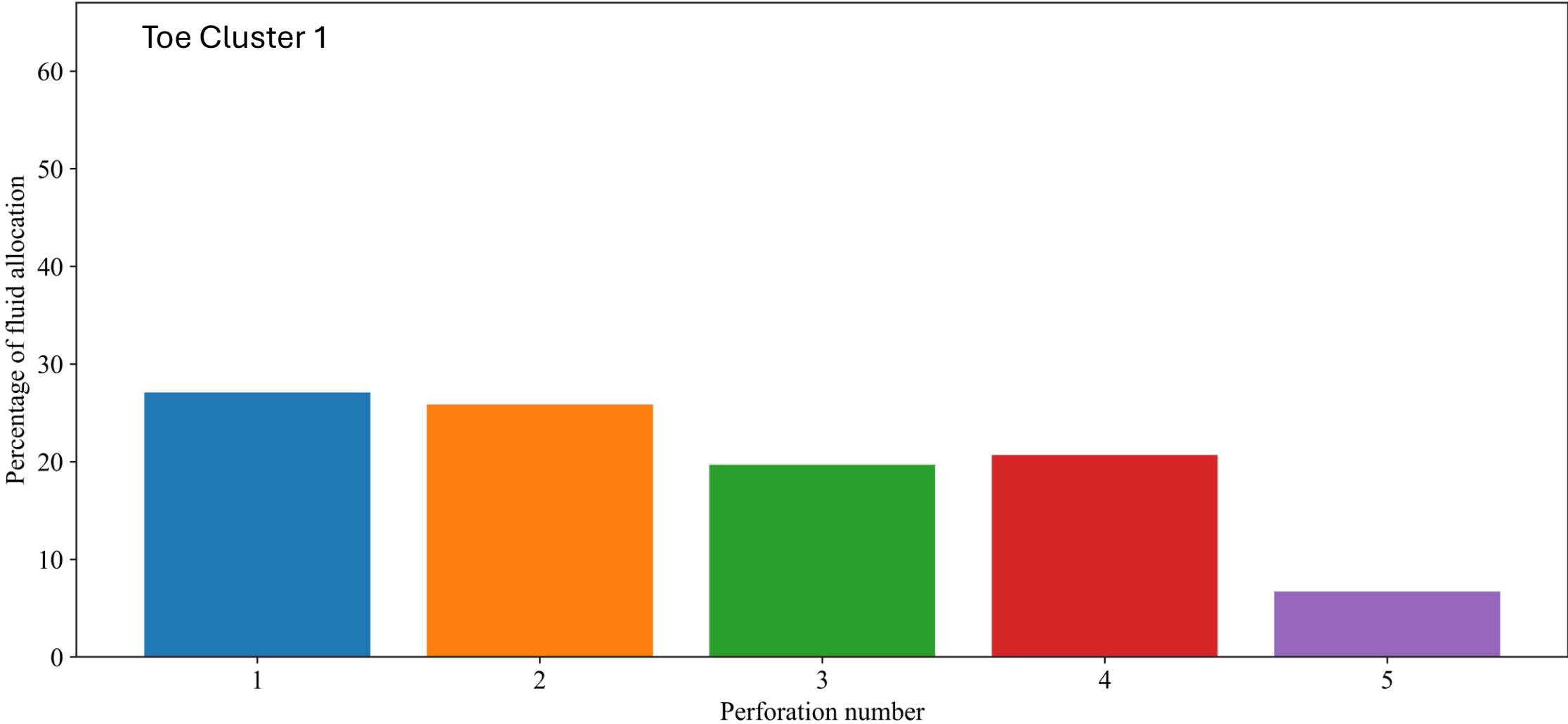
Fluid injection allocation for band: 8-32 Hz



Stage 2: 32-128 Hz



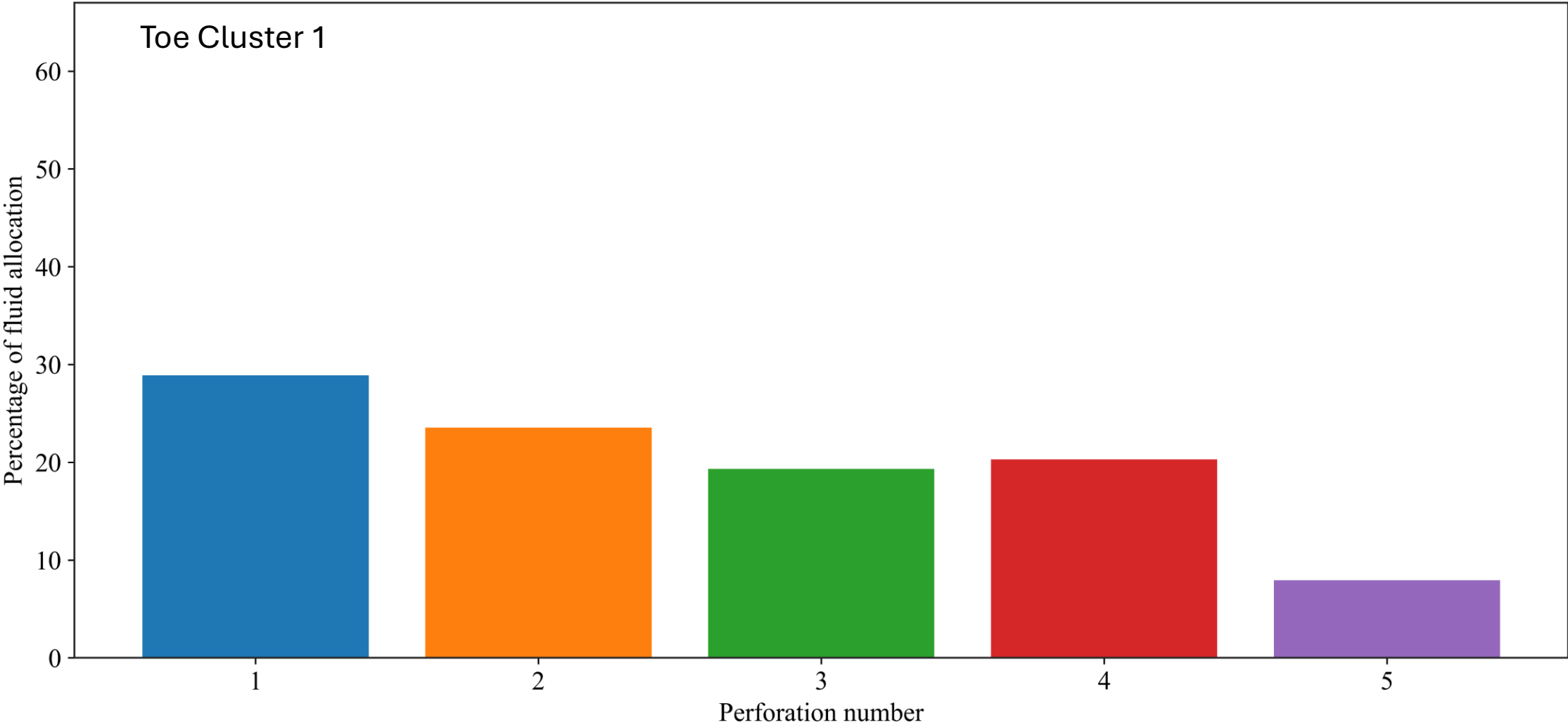
Fluid injection allocation for band: 32-128 Hz



Stage 2: 64-256 Hz



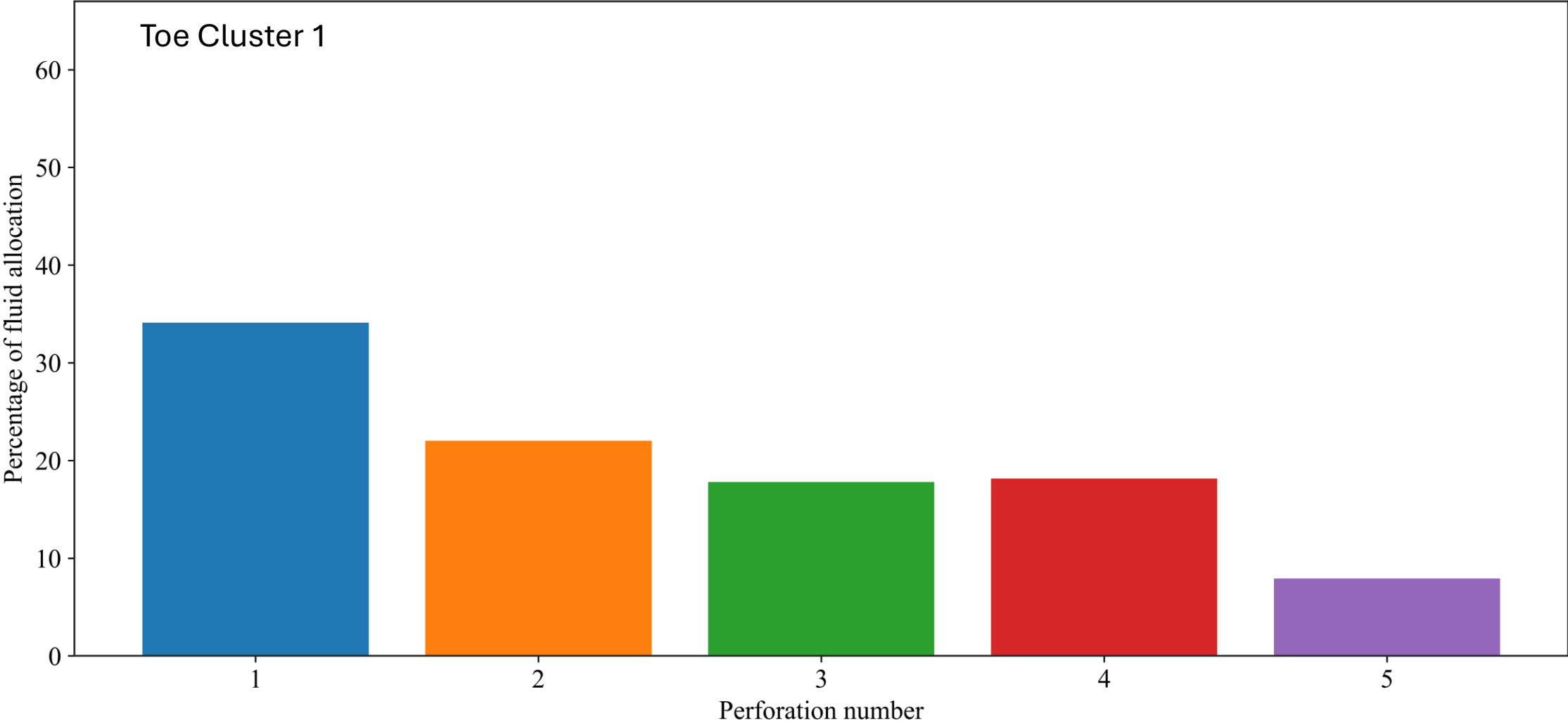
Fluid injection allocation for band: 64-256 Hz



Stage 2: 128-512 Hz



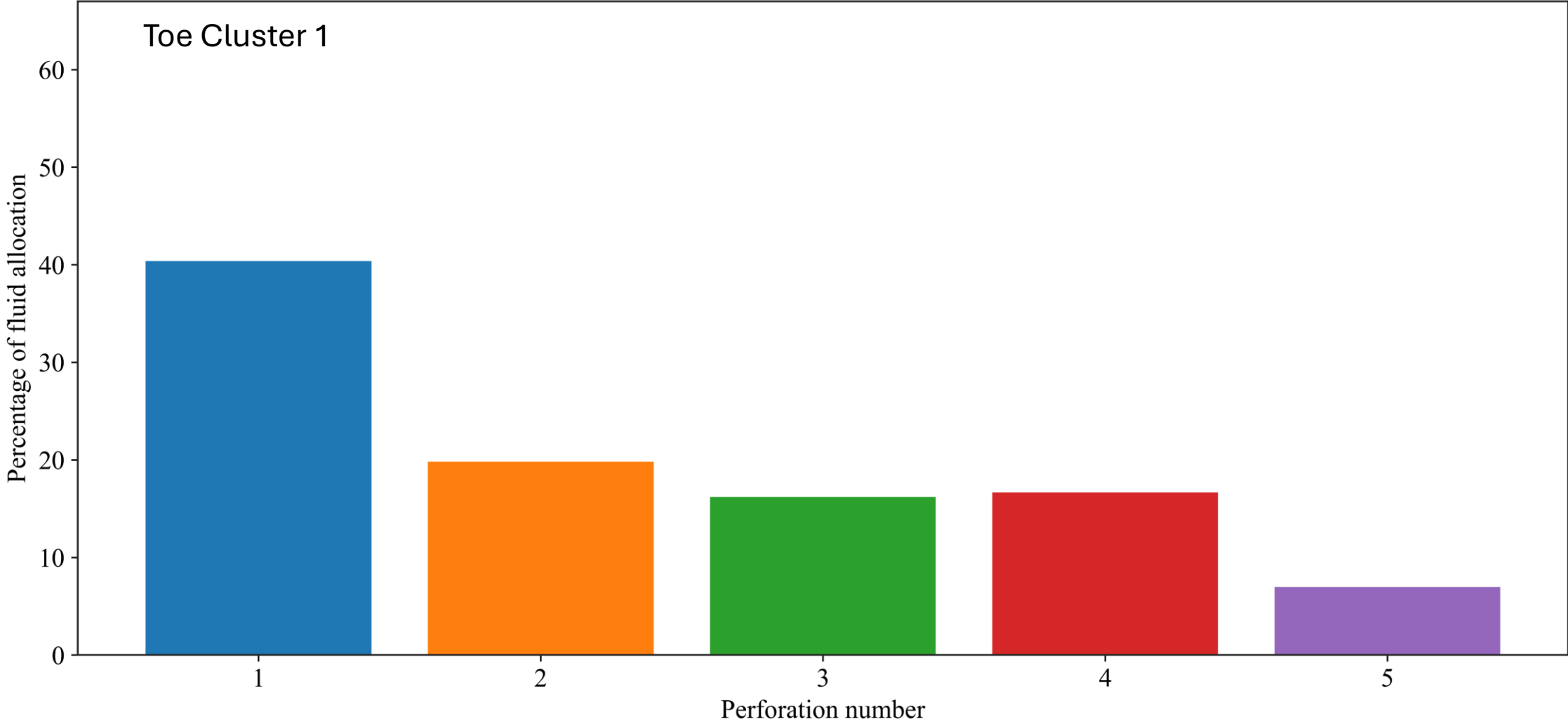
Fluid injection allocation for band: 128-512 Hz



Stage 2: 256-1024 Hz



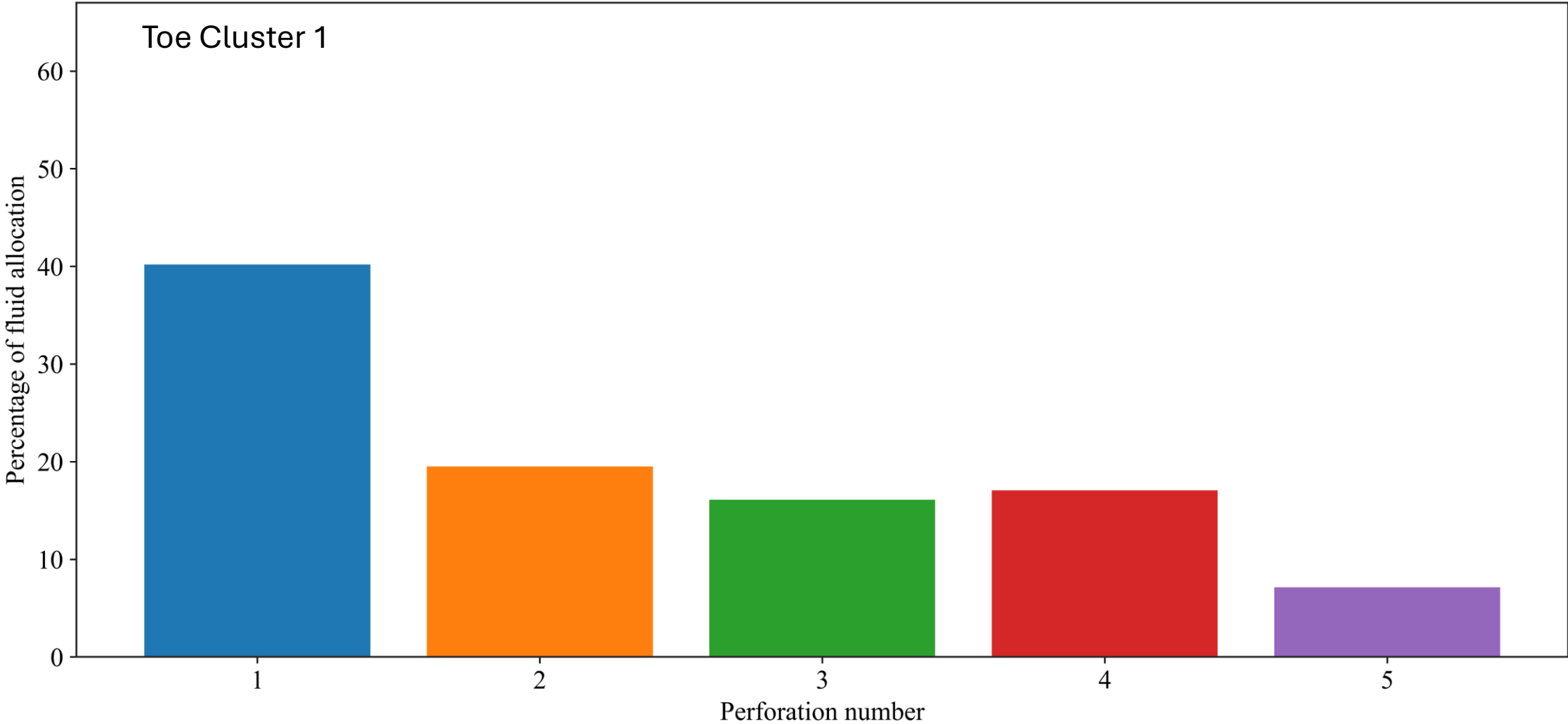
Fluid injection allocation for band: 256-1024 Hz



Stage 2: 512-2048 Hz



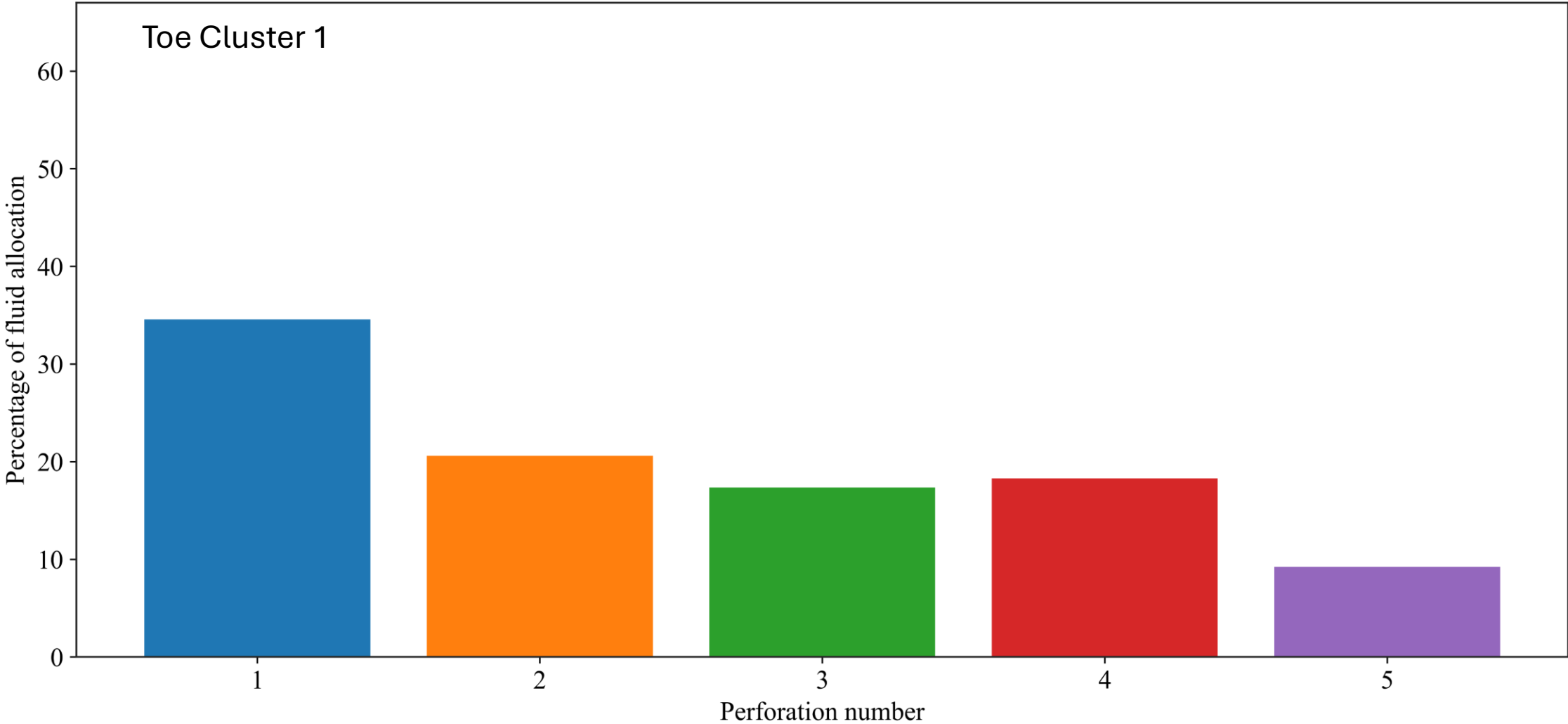
Fluid injection allocation for band: 512-2048 Hz



Stage 2: 1024-4096 Hz

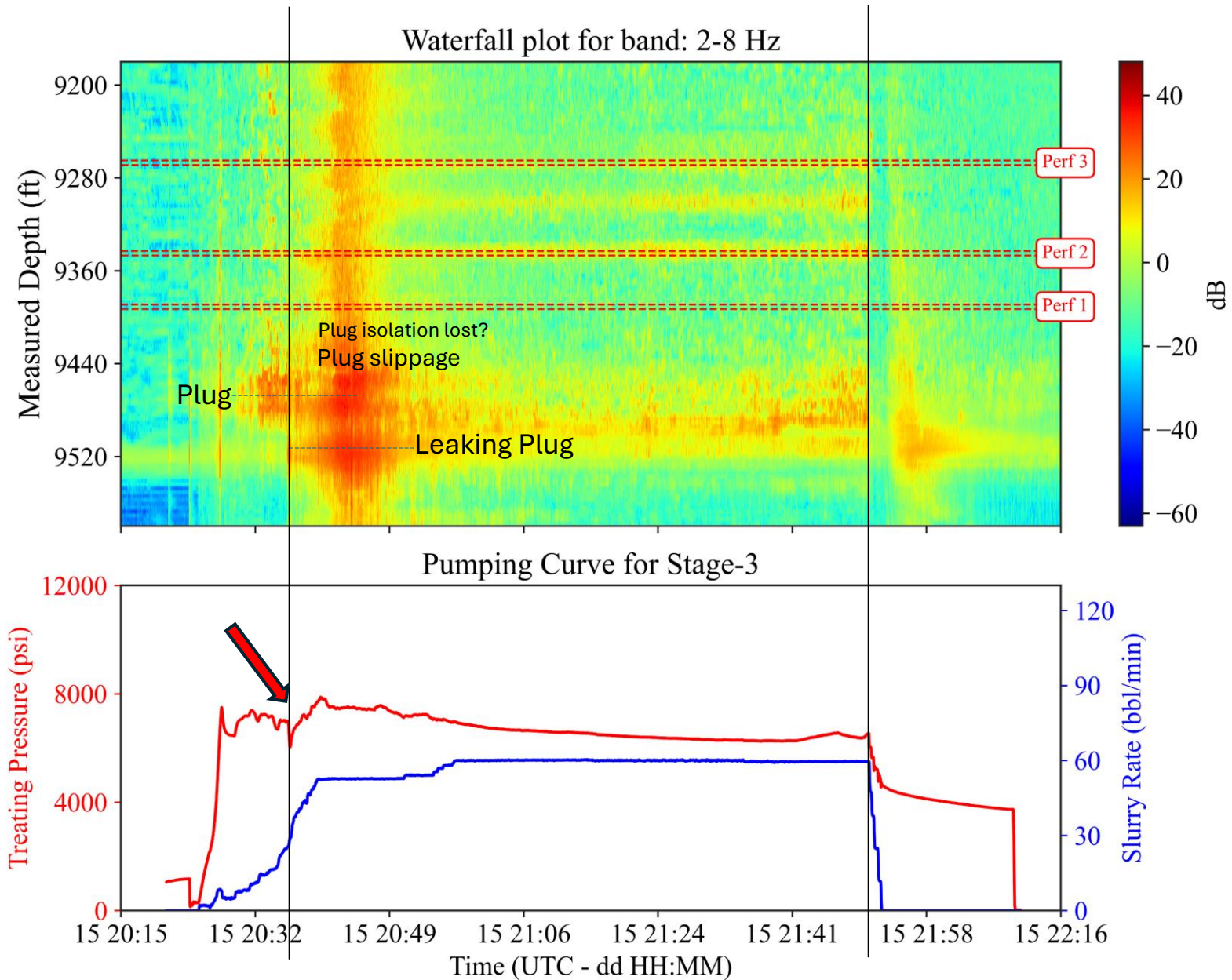


Fluid injection allocation for band: 1024-4096 Hz

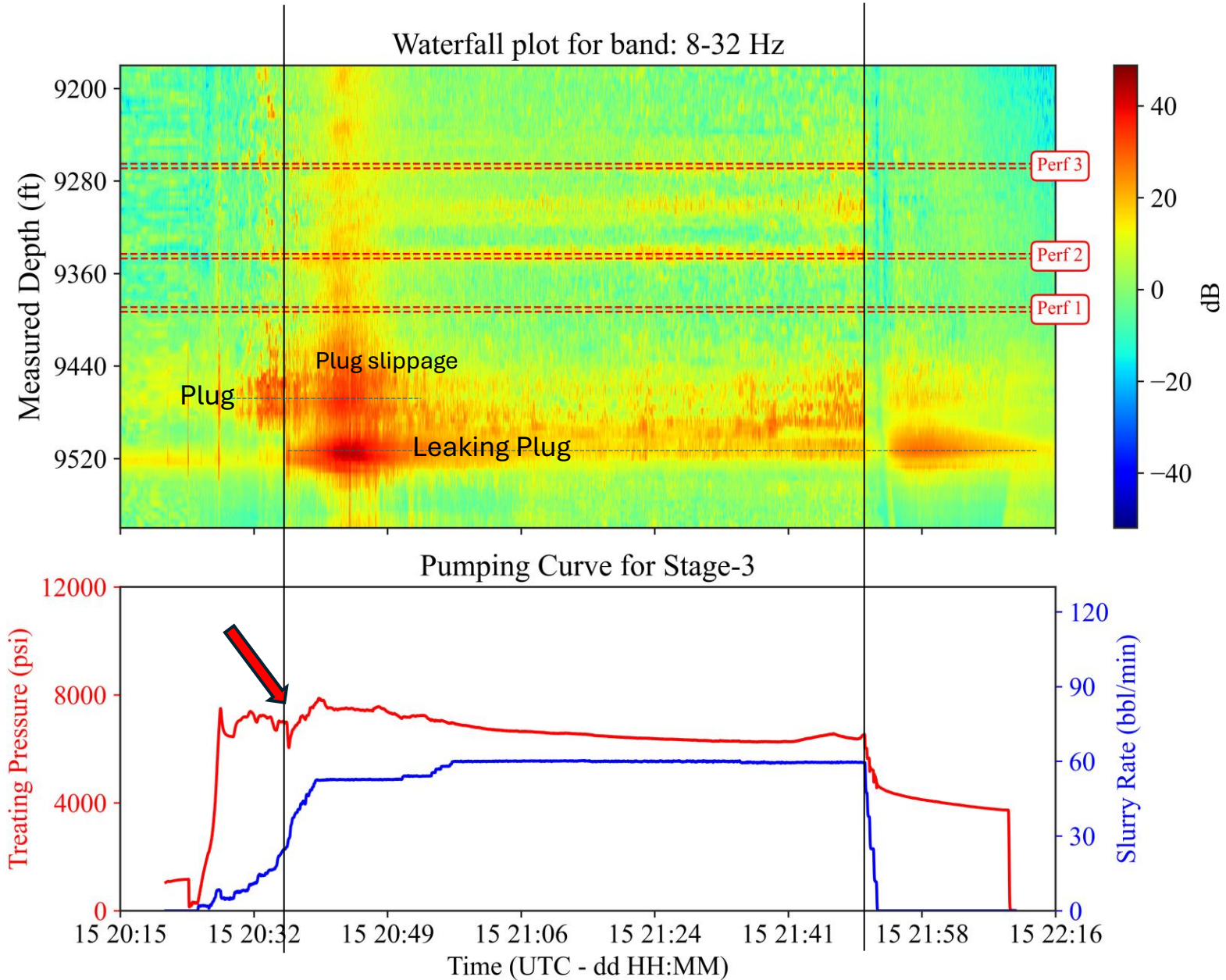


Stage 3: Apr 15, 20:25-21:53 (UTC Time)
Frequency Band Energy (FBE) Extractions
FBE Bands along with Pumping Curves

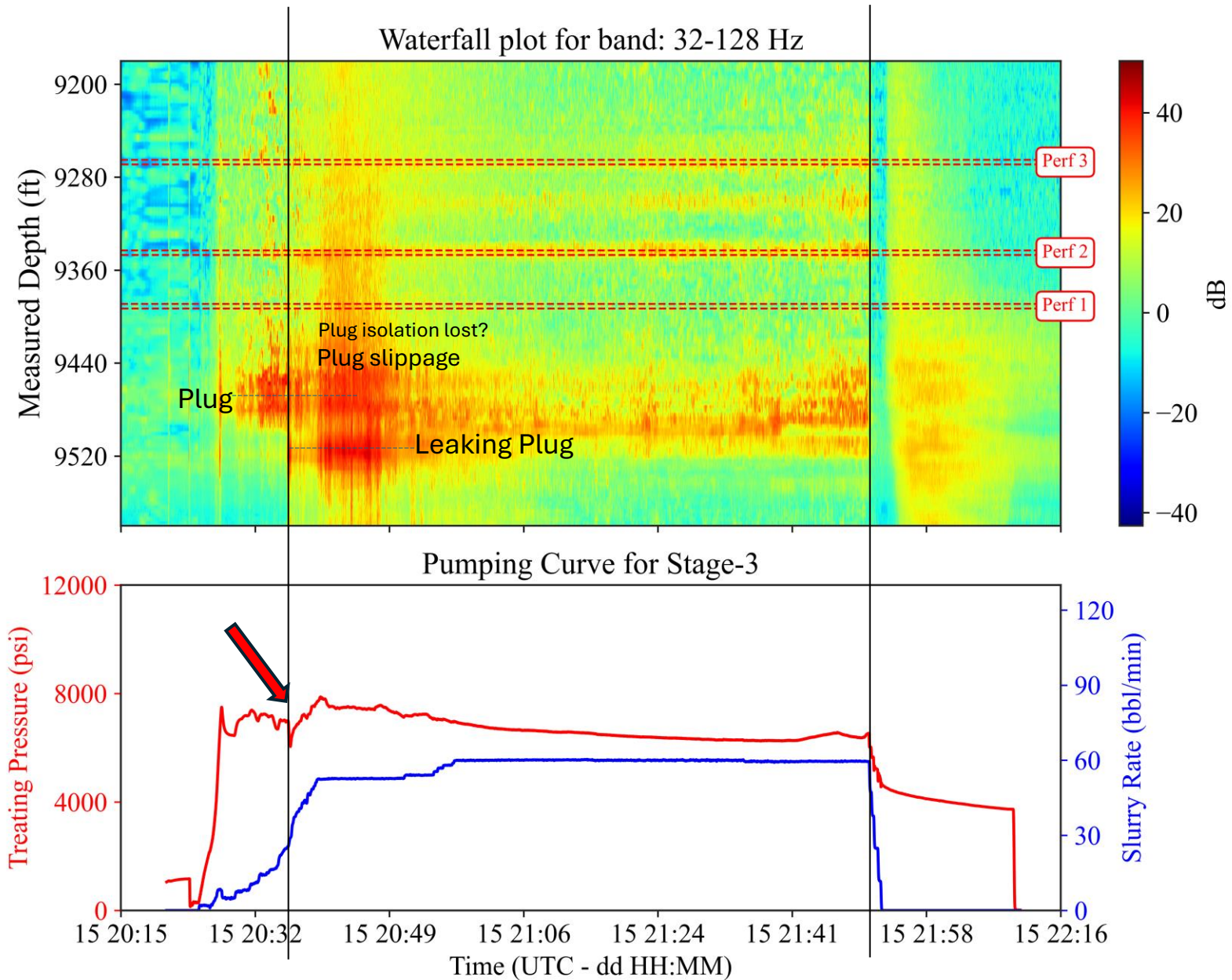
Stage 3: 2-8 Hz



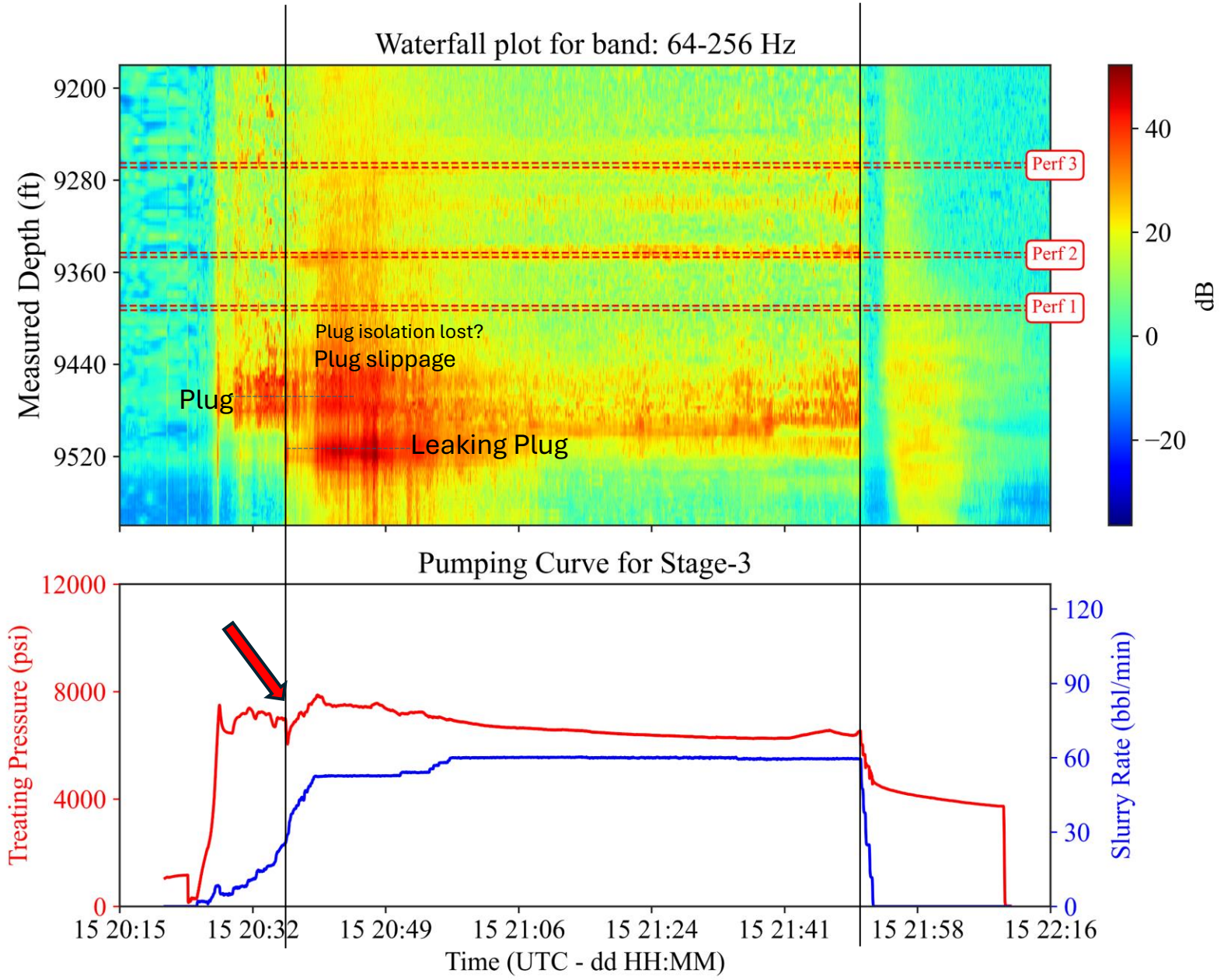
Stage 3: 8-32 Hz



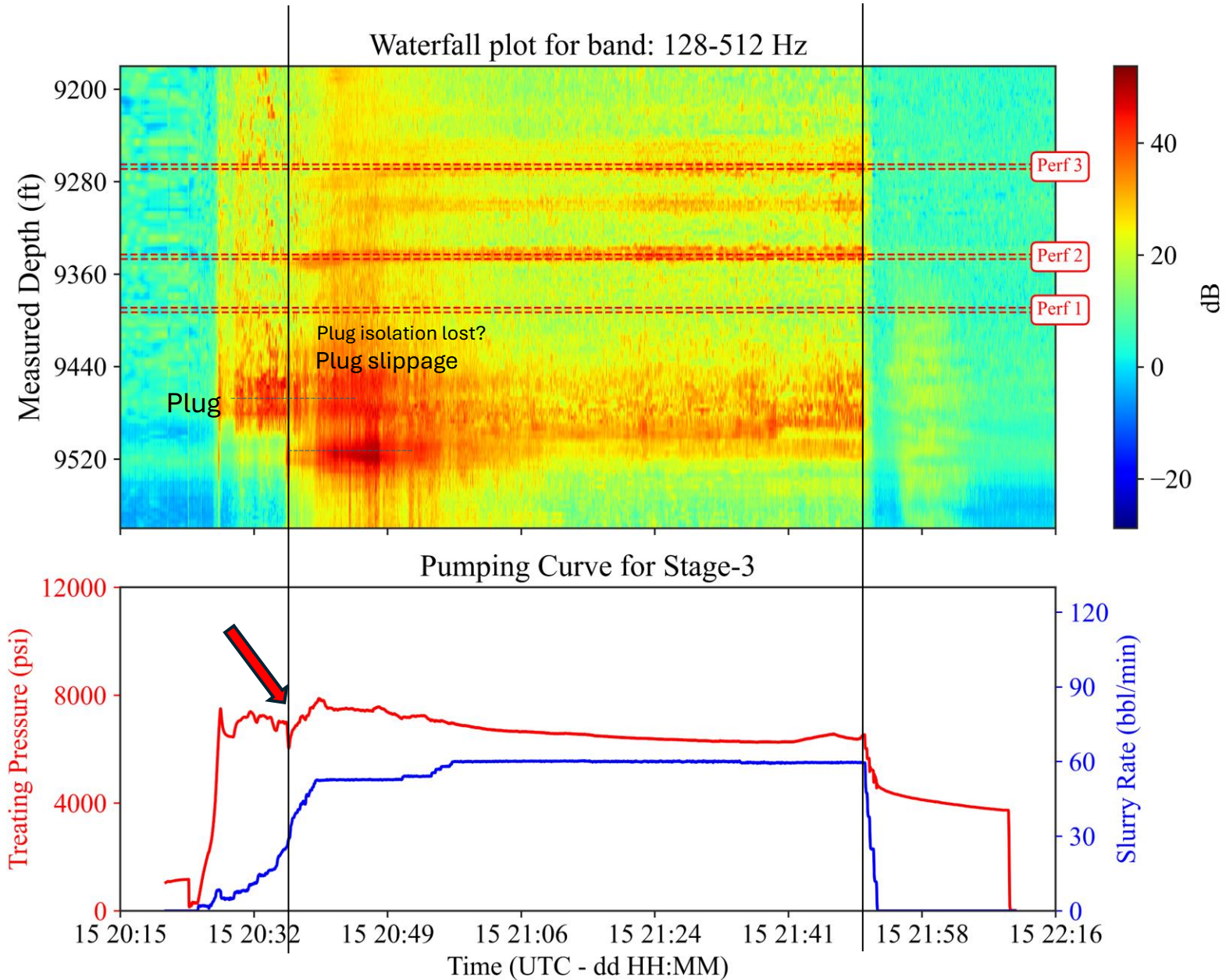
Stage 3: 32-128 Hz



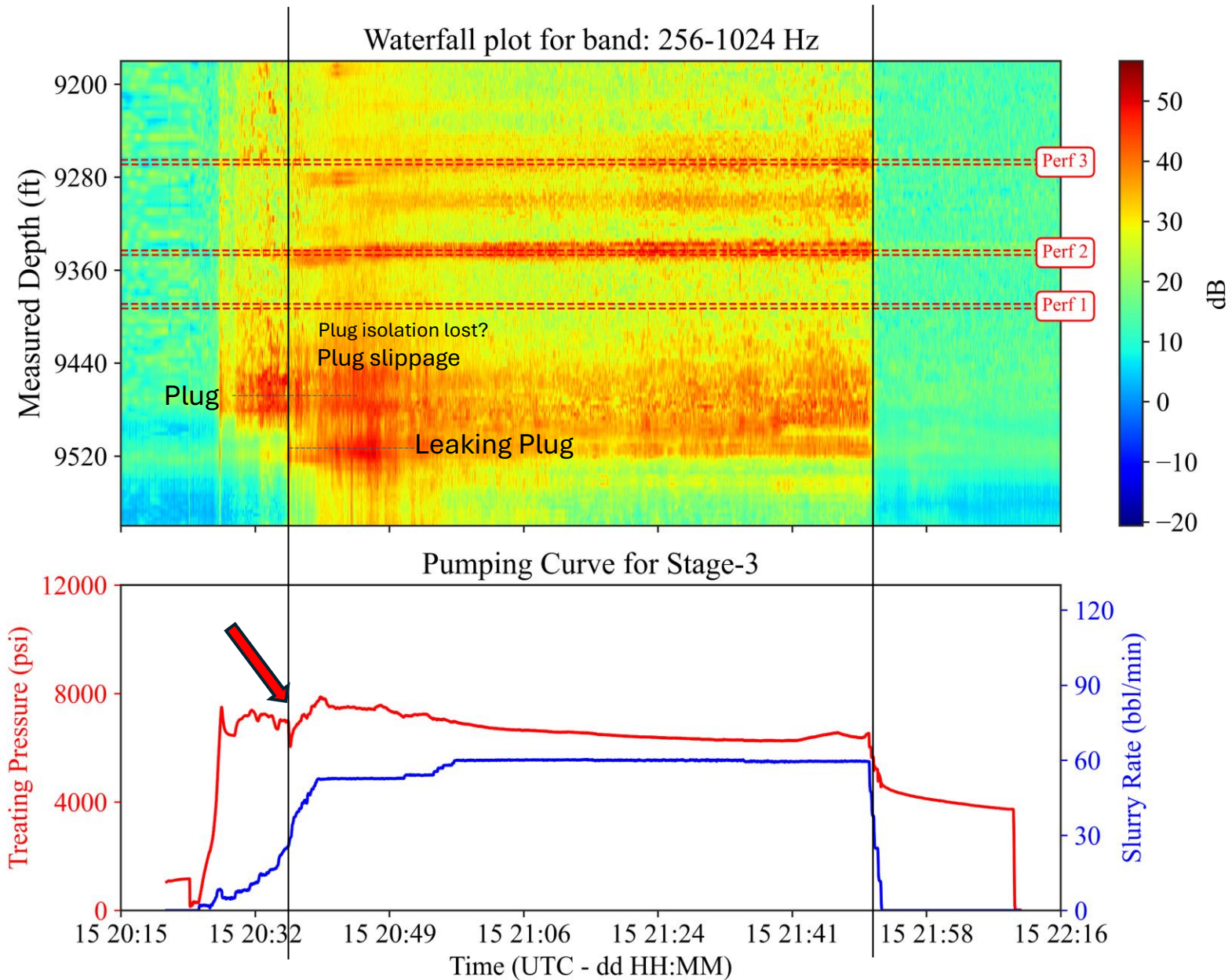
Stage 3: 64-256 Hz



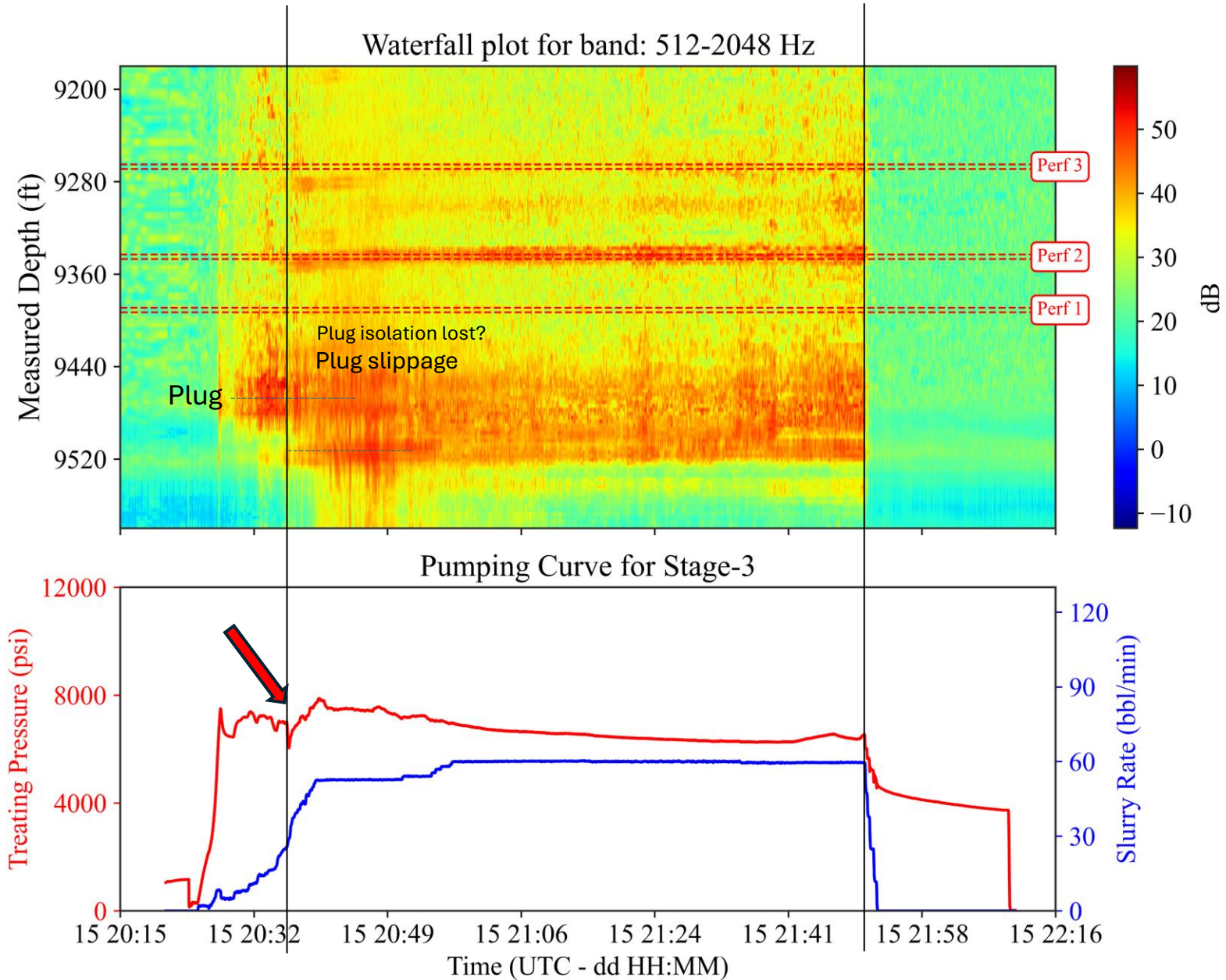
Stage 3: 128-512 Hz



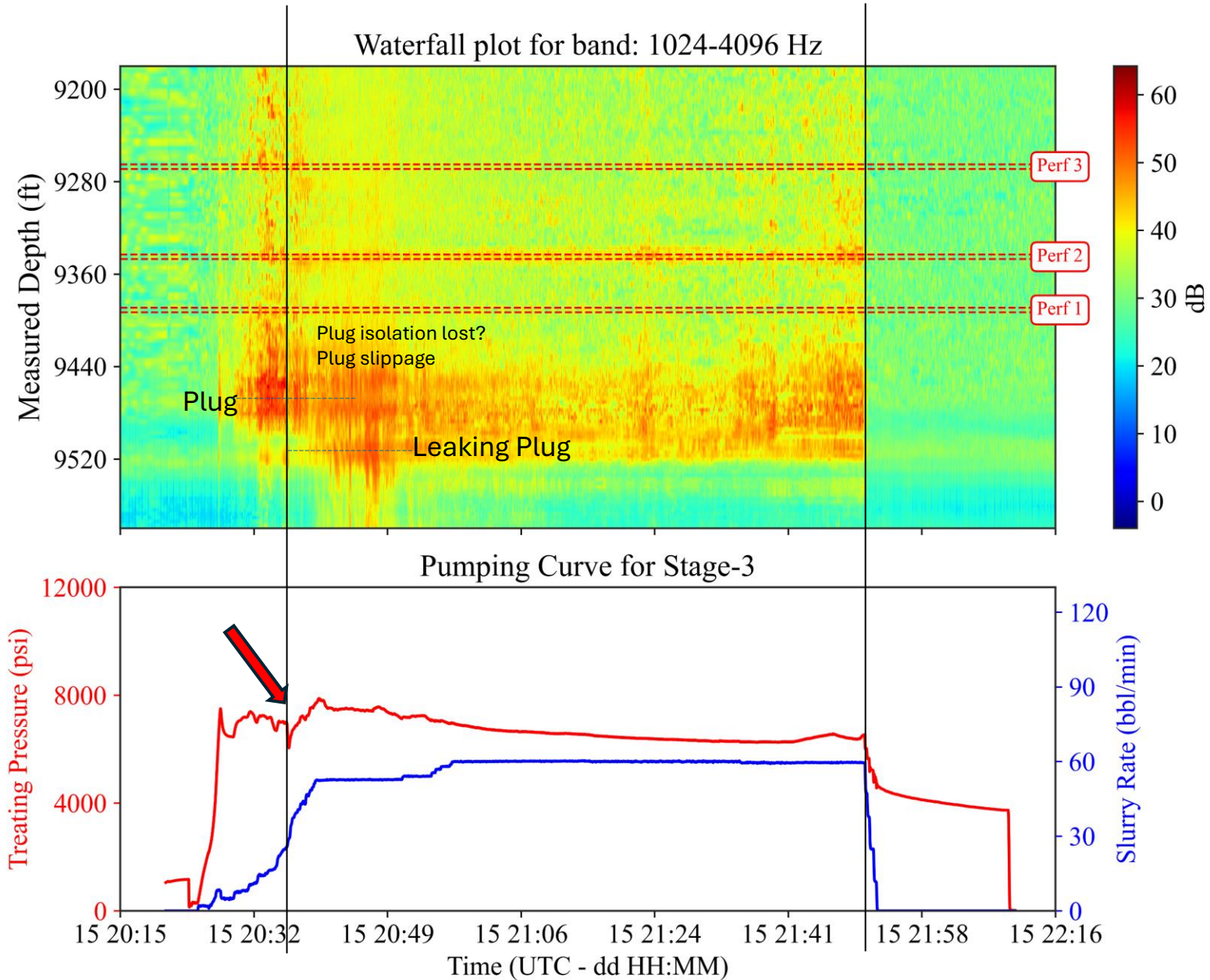
Stage 3: 256-1024 Hz



Stage 3: 512-2048 Hz



Stage 3: 1024-4096 Hz



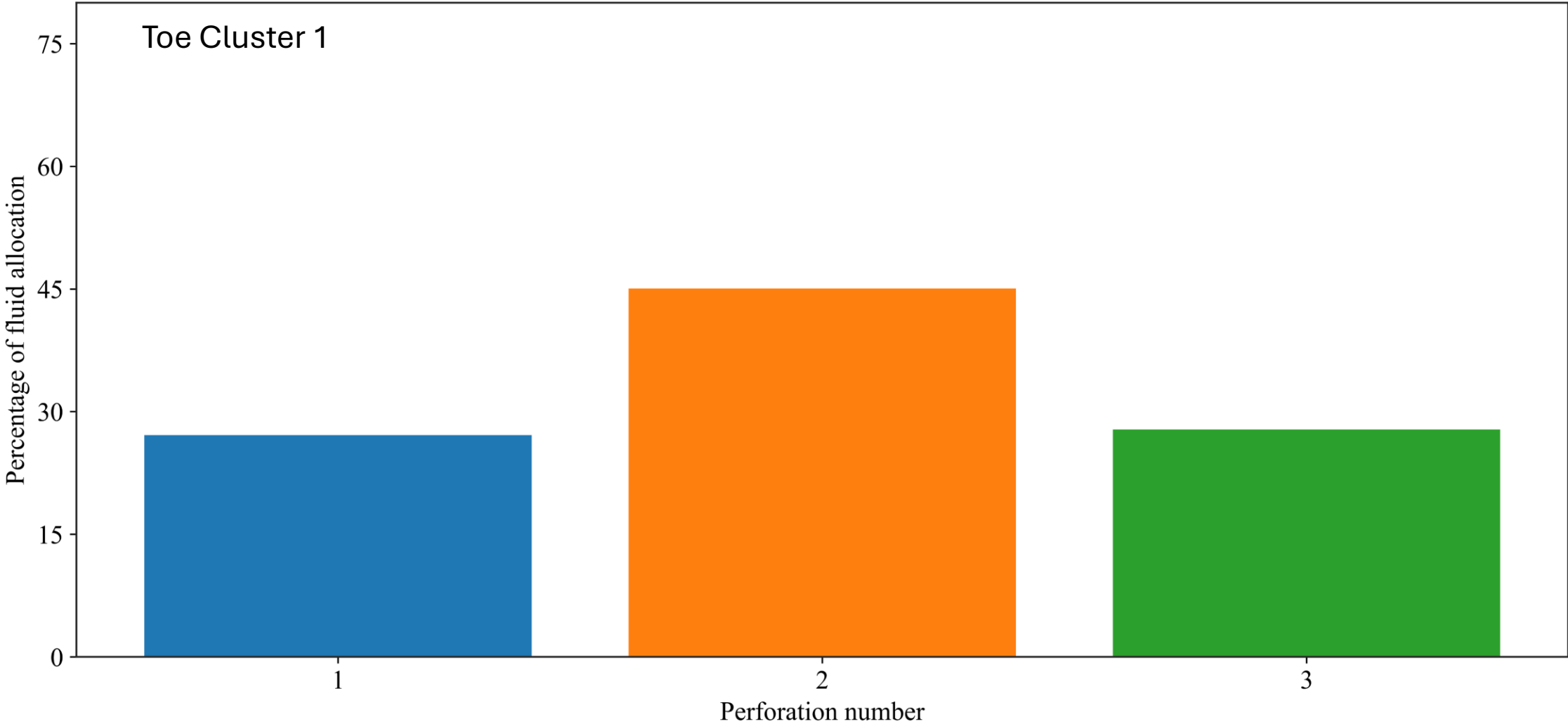
Stage 3: Apr 15, 20:25-21:53 (UTC Time)

Injection Allocation Plots

Stage 3: 2-8 Hz



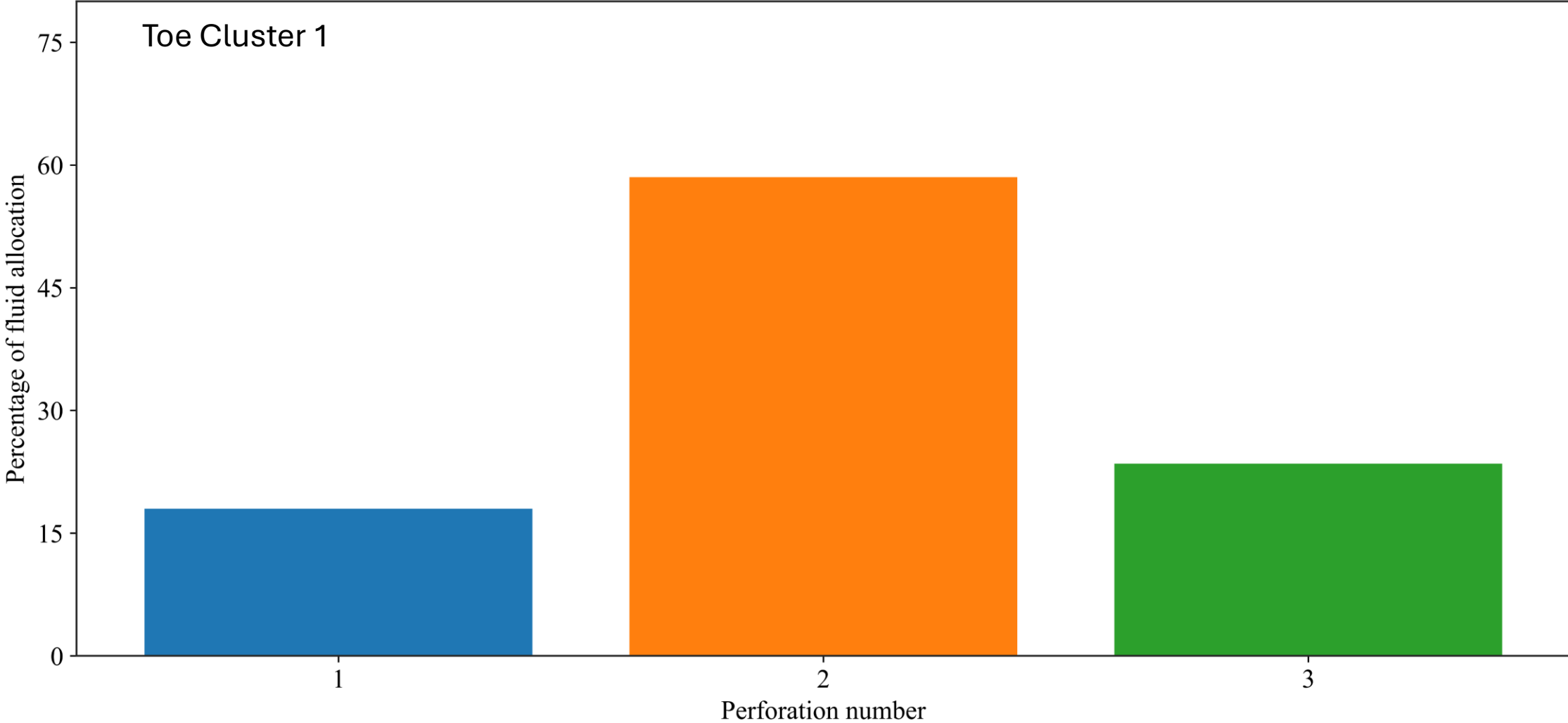
Fluid injection allocation for band: 2-8 Hz



Stage 3: 8-32 Hz



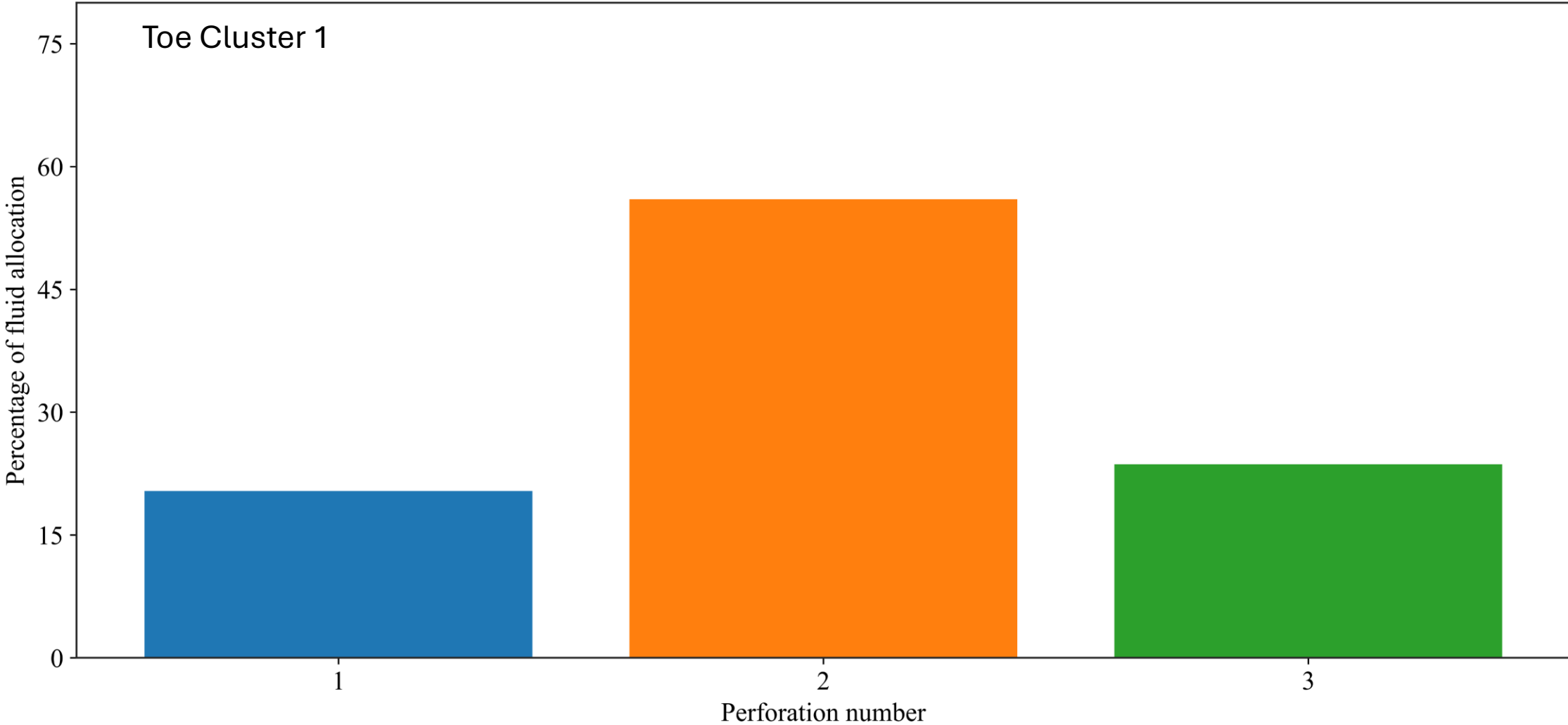
Fluid injection allocation for band: 8-32 Hz



Stage 3: 32-128 Hz



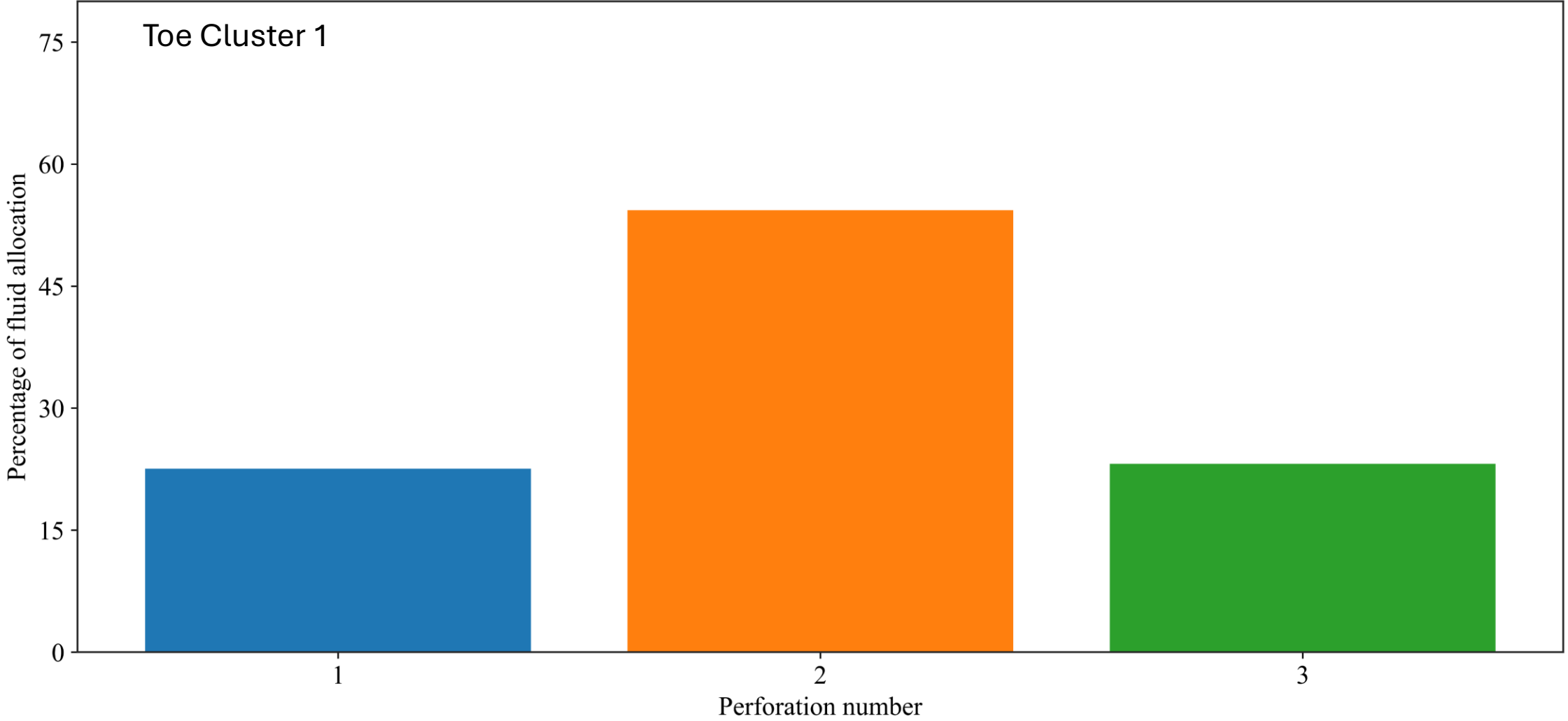
Fluid injection allocation for band: 32-128 Hz



Stage 3: 64-256 Hz



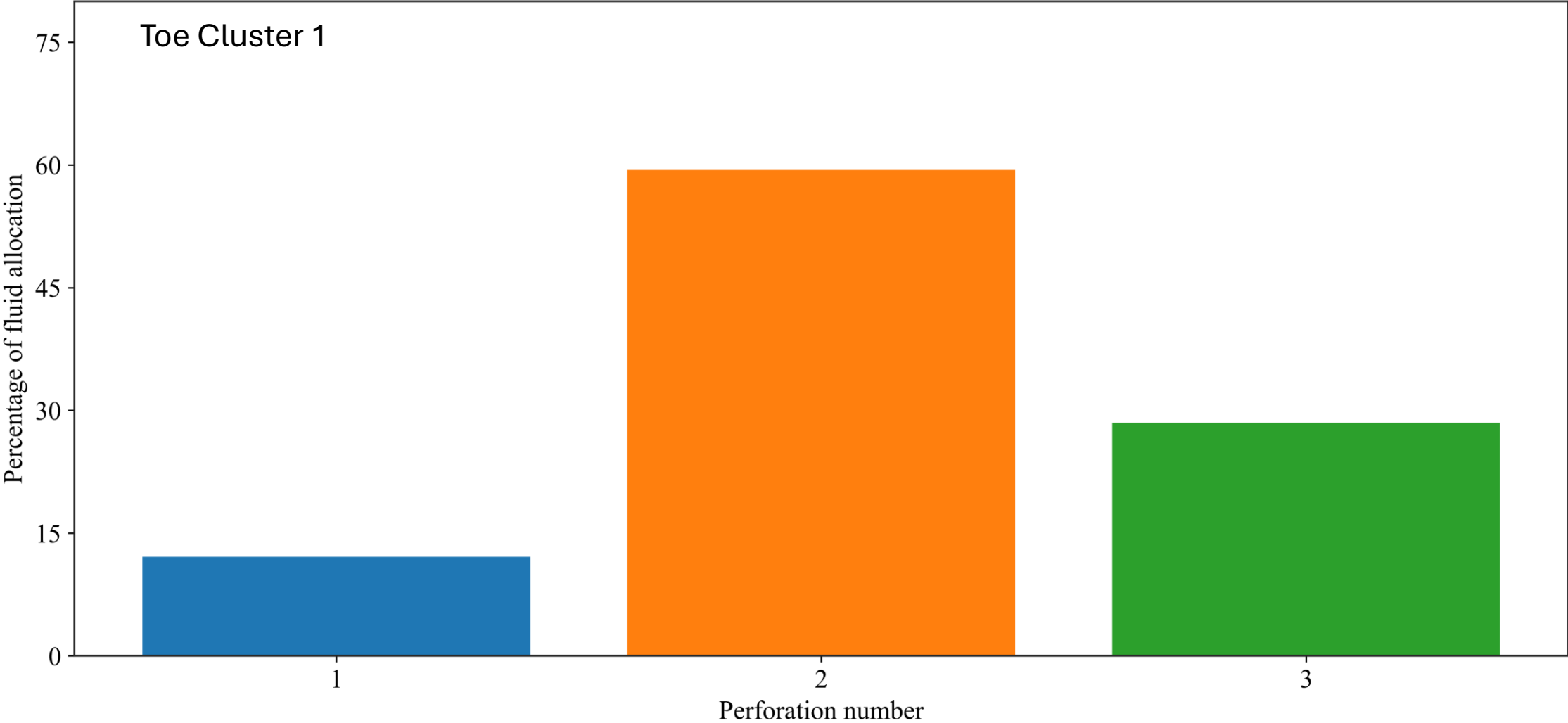
Fluid injection allocation for band: 64-256 Hz



Stage 3: 128-512 Hz



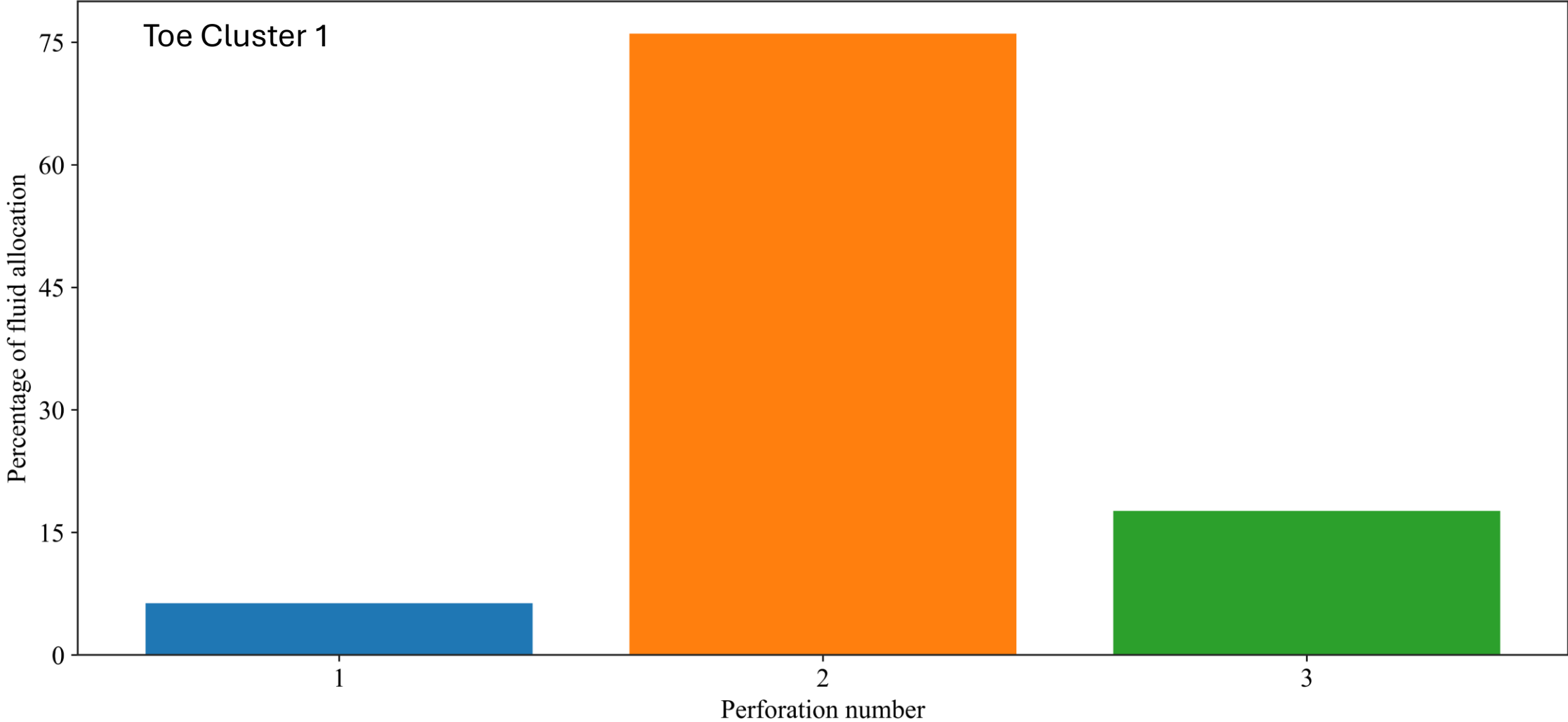
Fluid injection allocation for band: 128-512 Hz



Stage 3: 256-1024 Hz



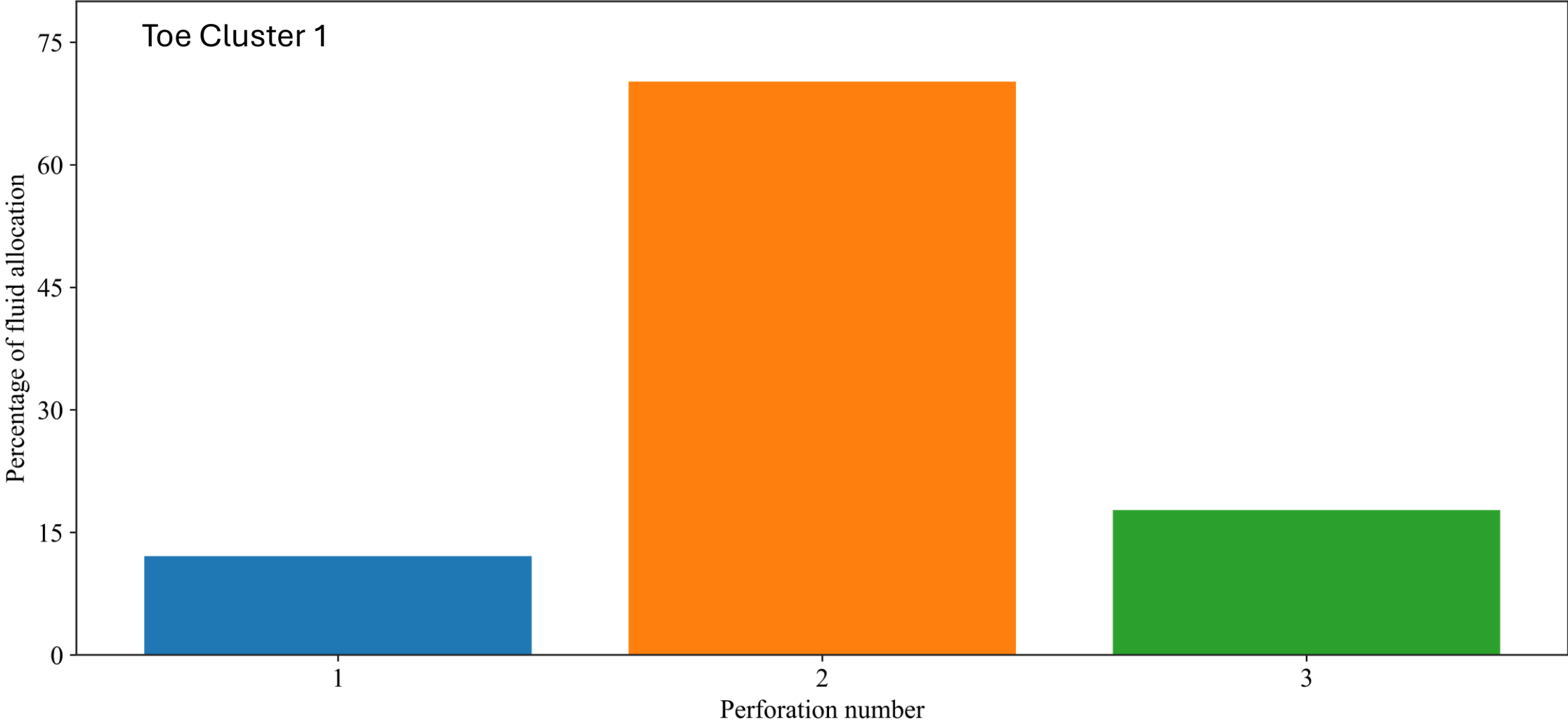
Fluid injection allocation for band: 256-1024 Hz



Stage 3: 512-2048 Hz



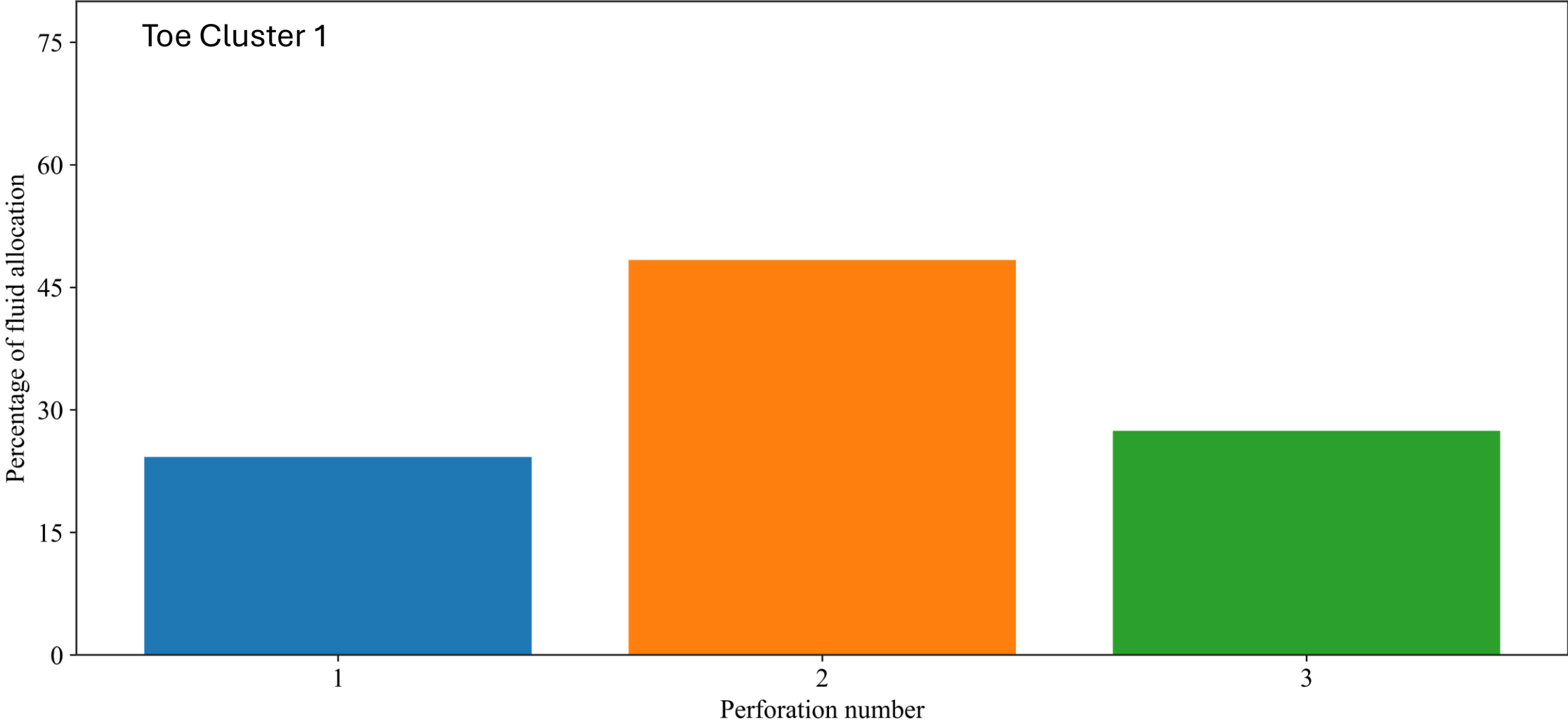
Fluid injection allocation for band: 512-2048 Hz



Stage 3: 1024-4096 Hz

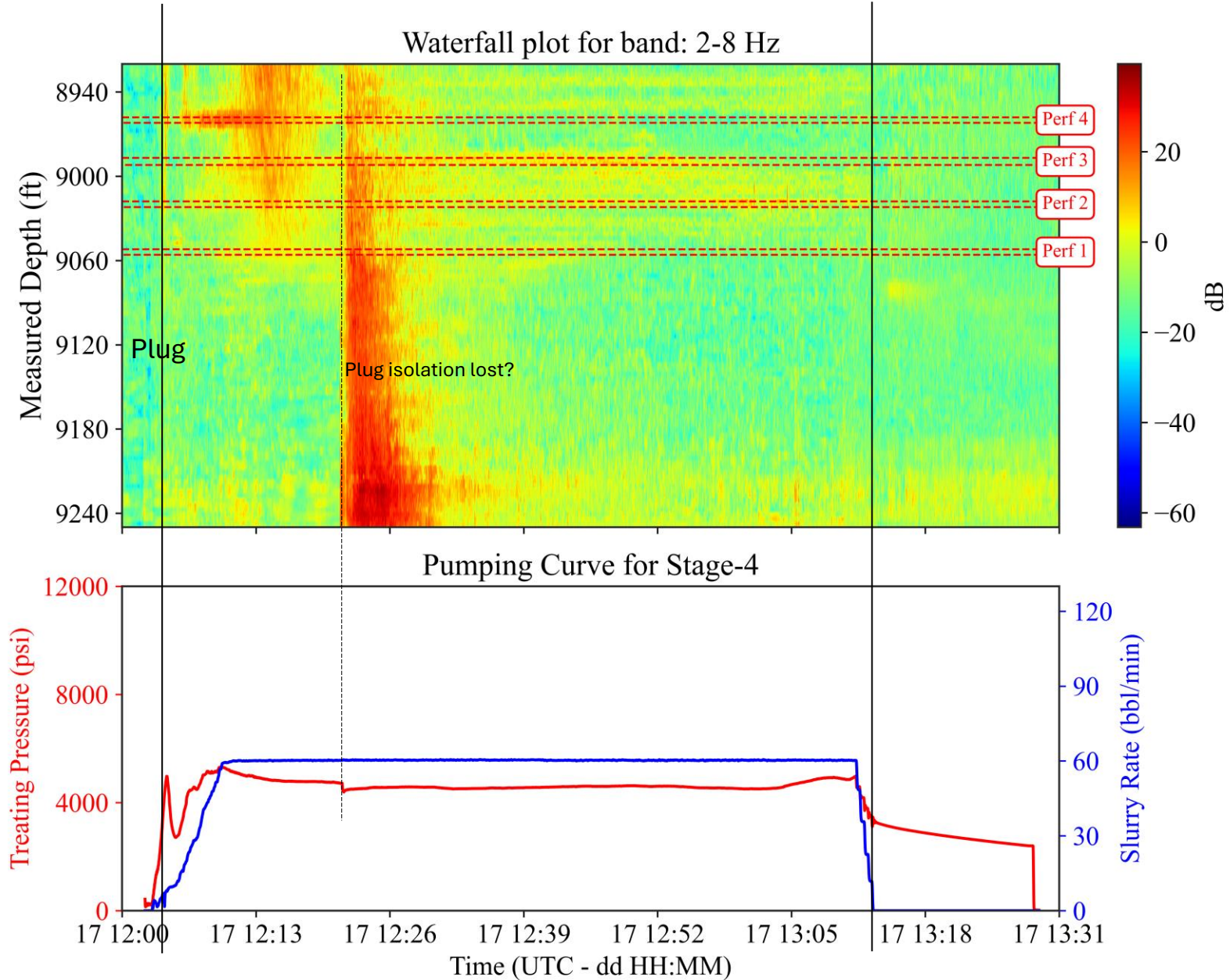


Fluid injection allocation for band: 1024-4096 Hz

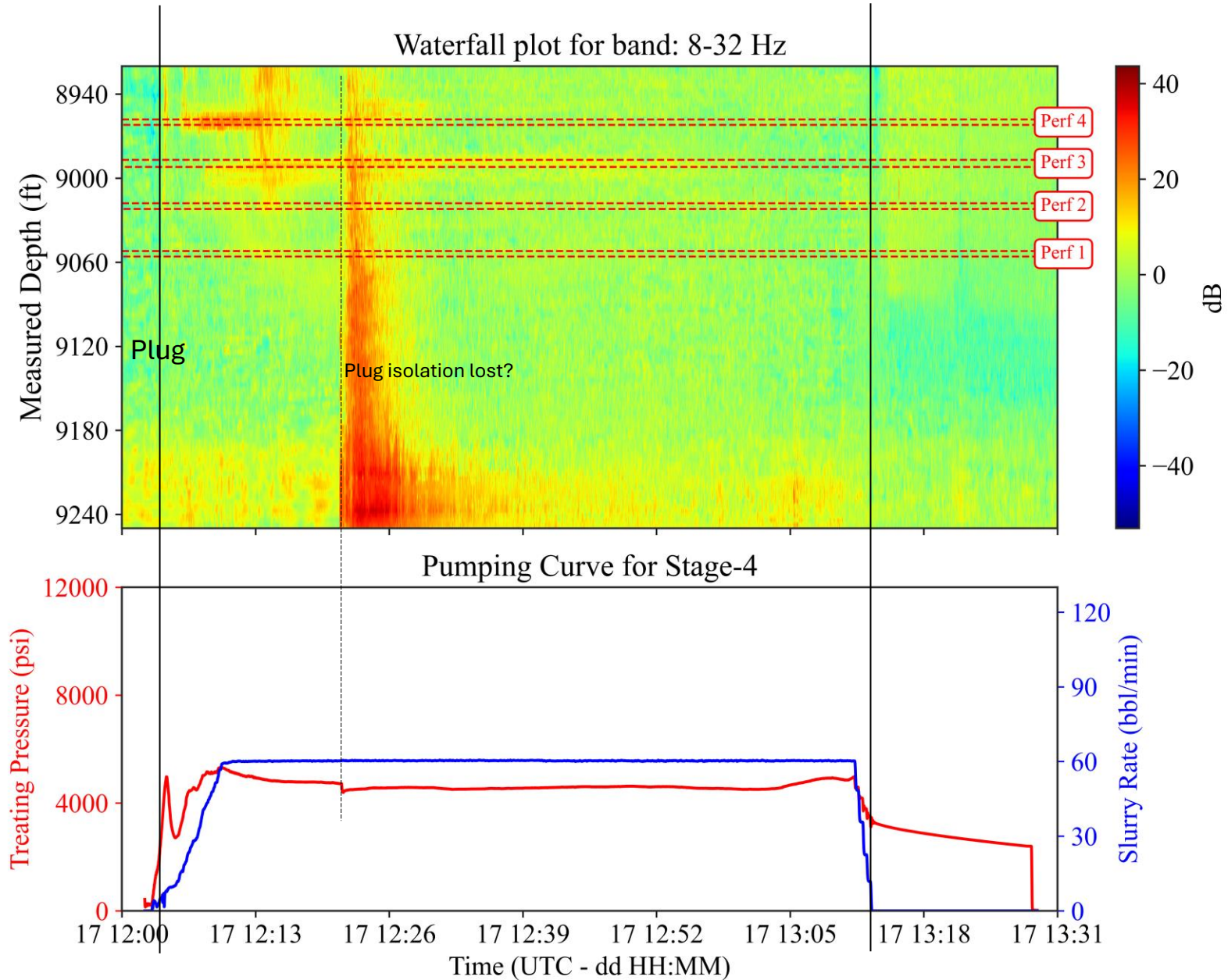


Stage 4: Apr 17, 12:02-13:12 (UTC Time)
Frequency Band Energy (FBE) Extractions
FBE Bands along with Pumping Curves

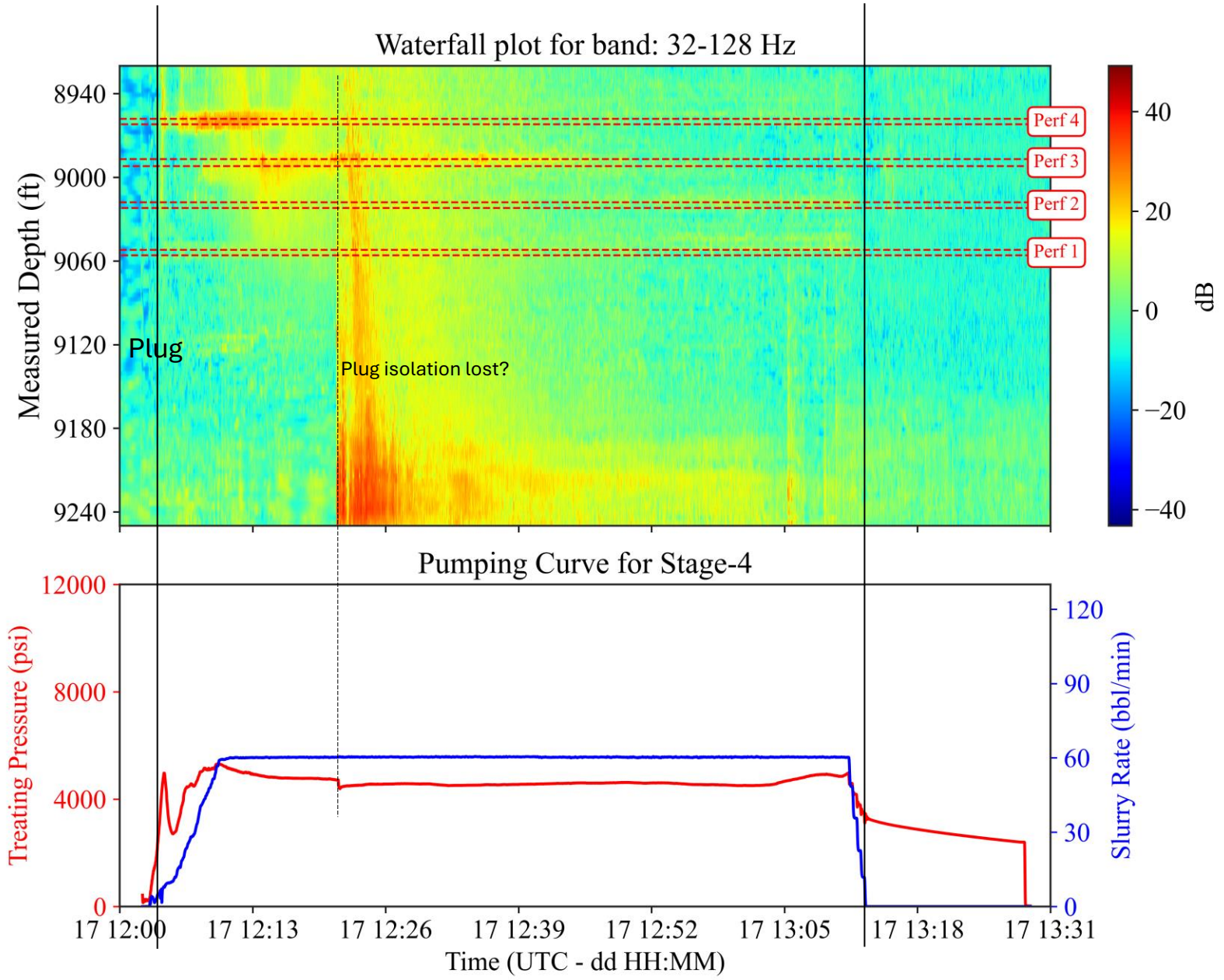
Stage 4: 2-8 Hz



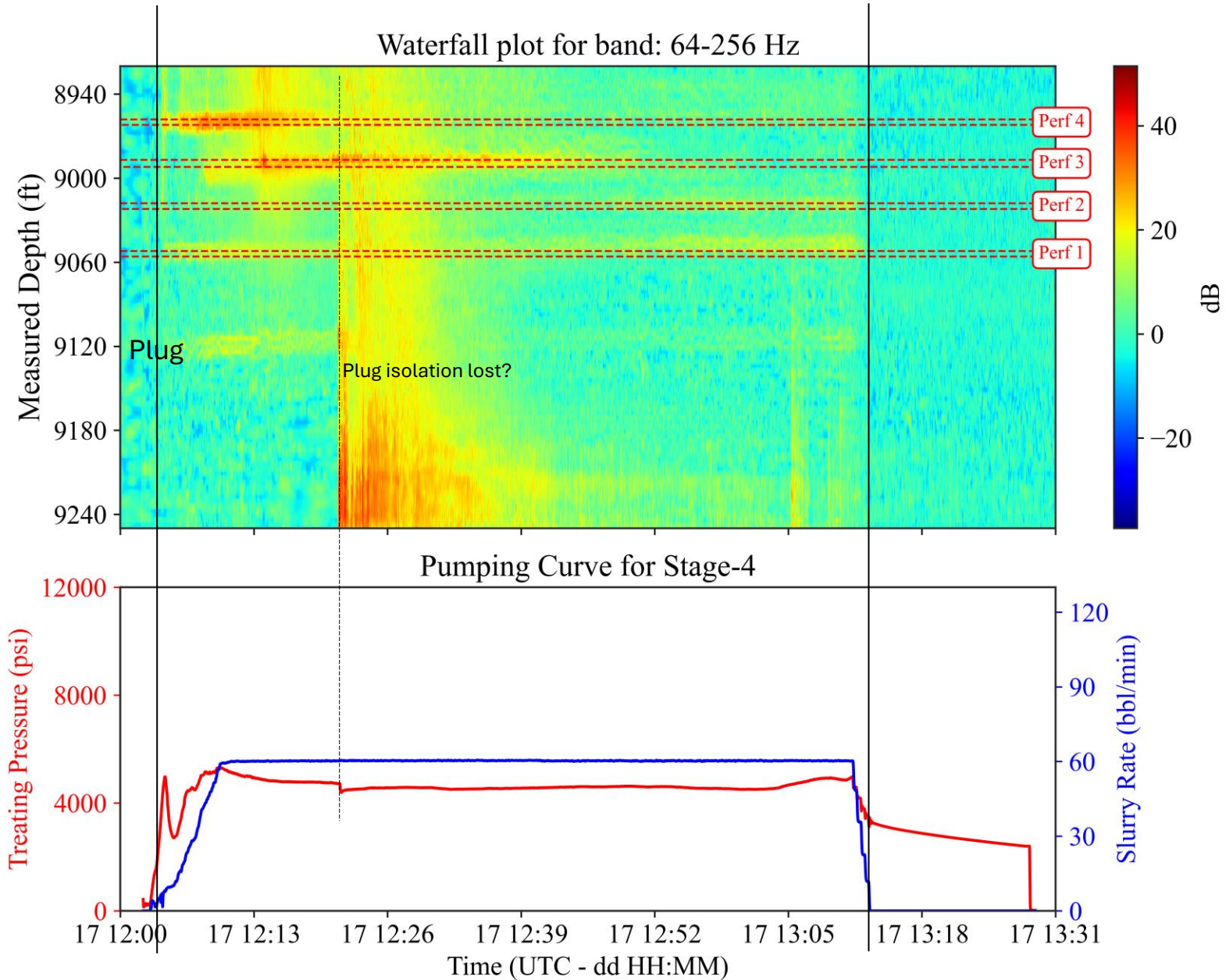
Stage 4: 8-32 Hz



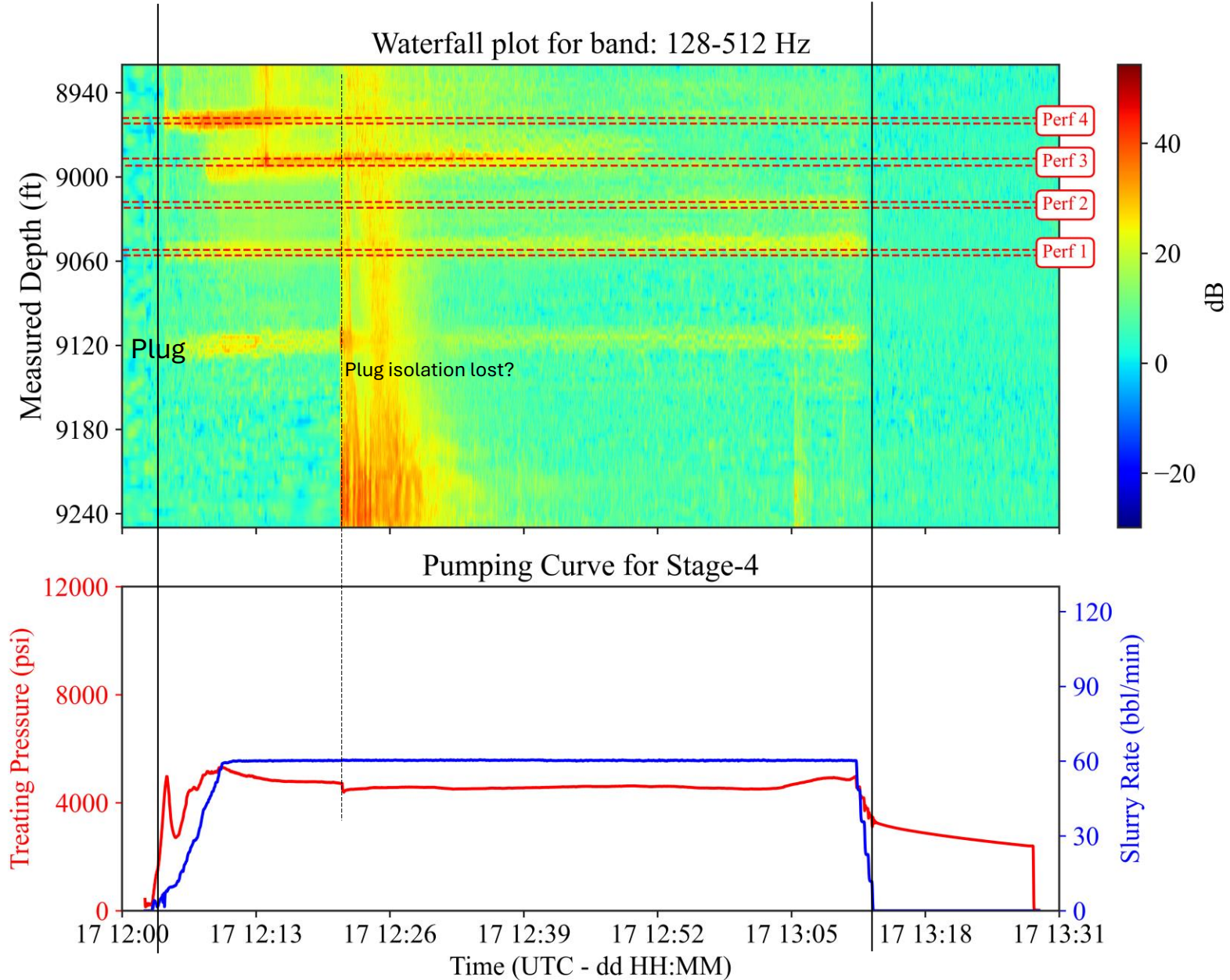
Stage 4: 32-128 Hz



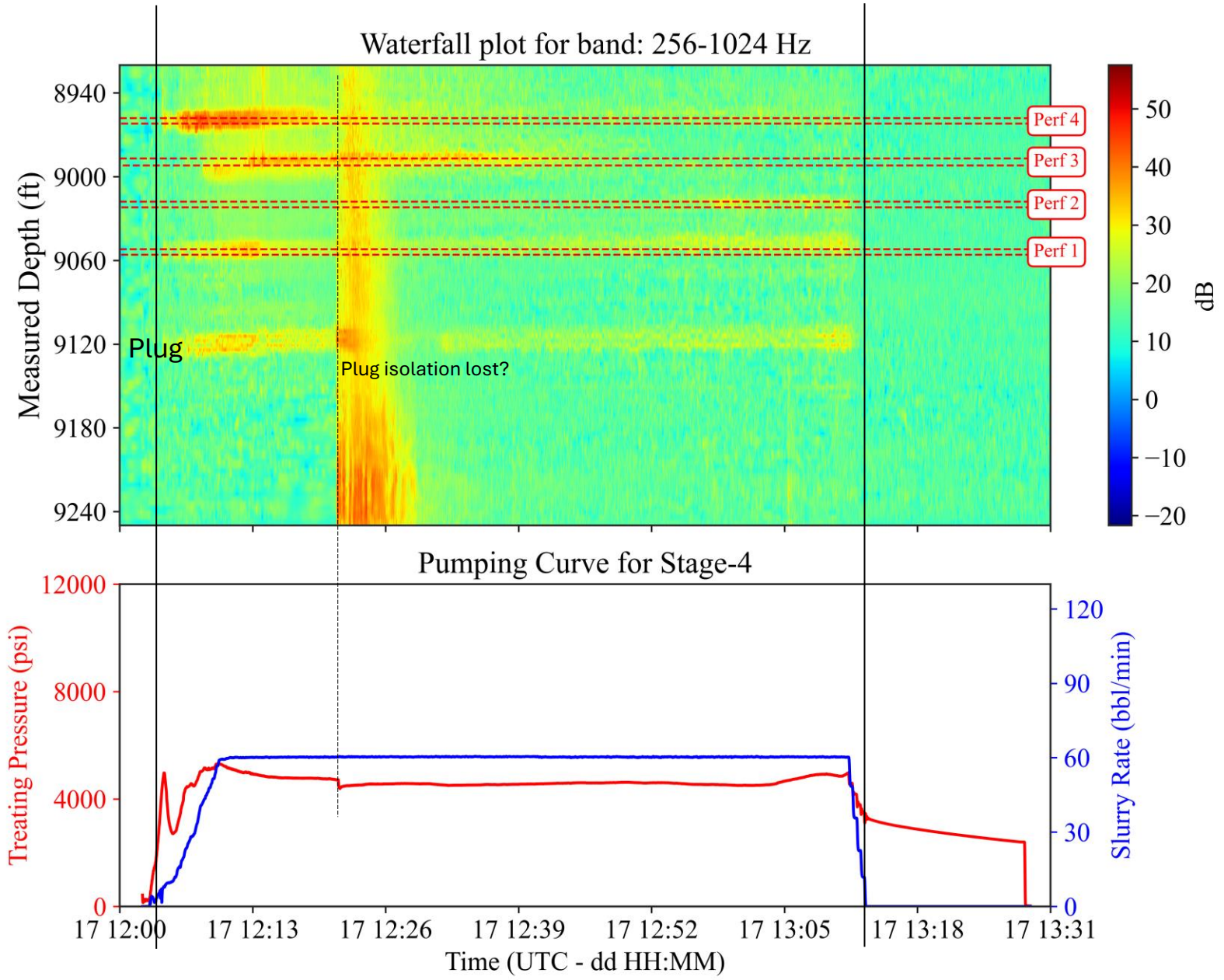
Stage 4: 64-256 Hz



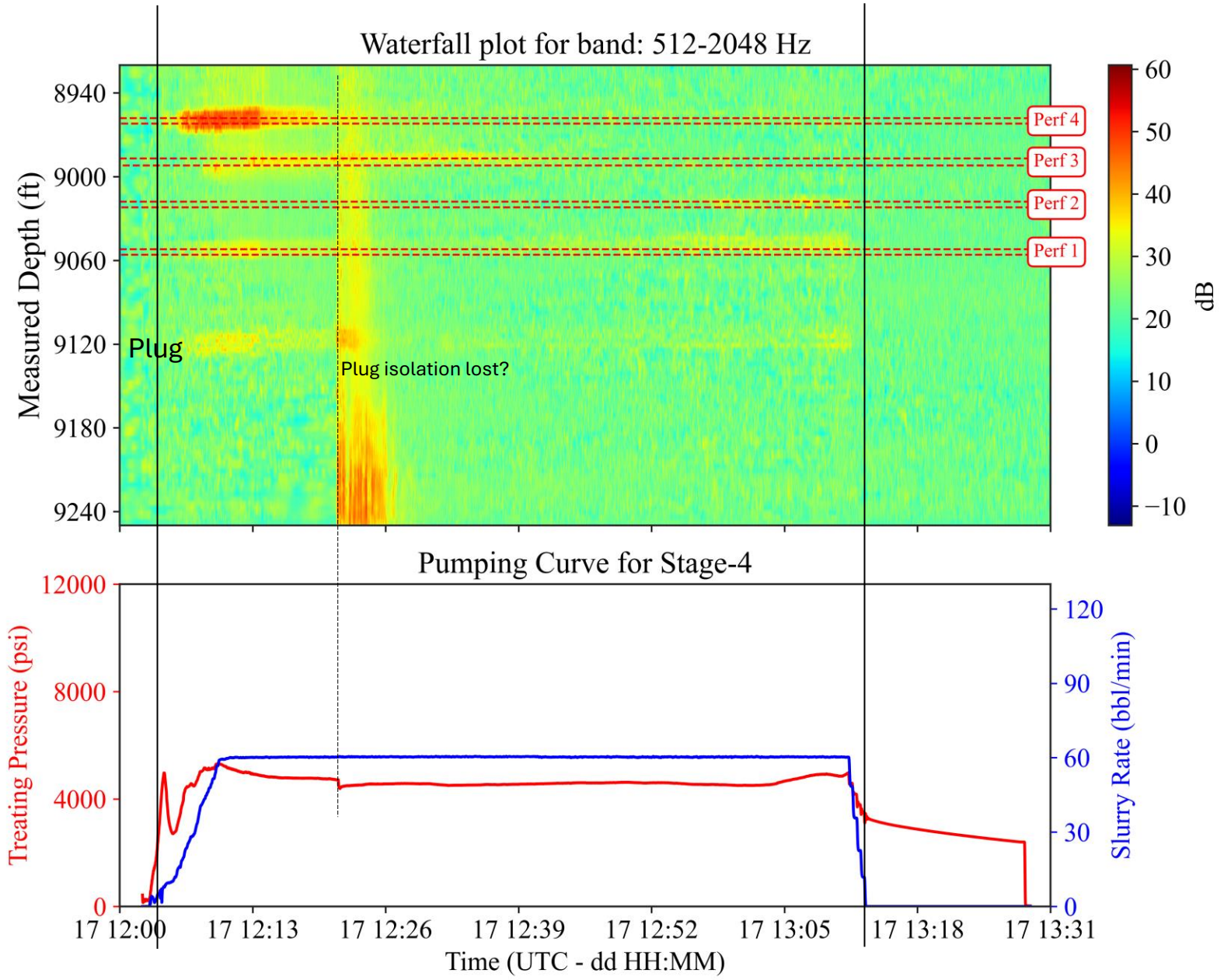
Stage 4: 128-512 Hz



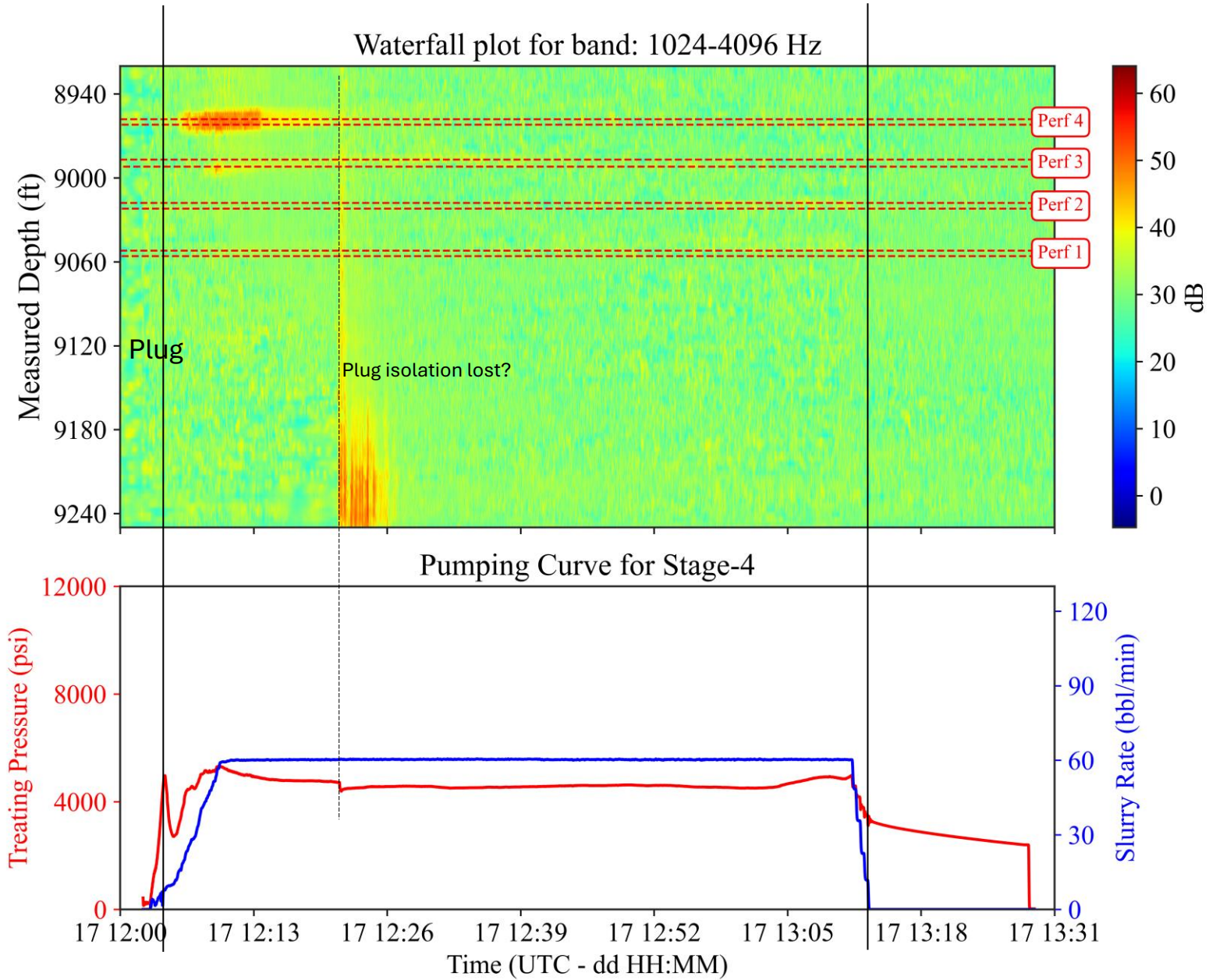
Stage 4: 256-1024 Hz



Stage 4: 512-2048 Hz



Stage 4: 1024-4096 Hz



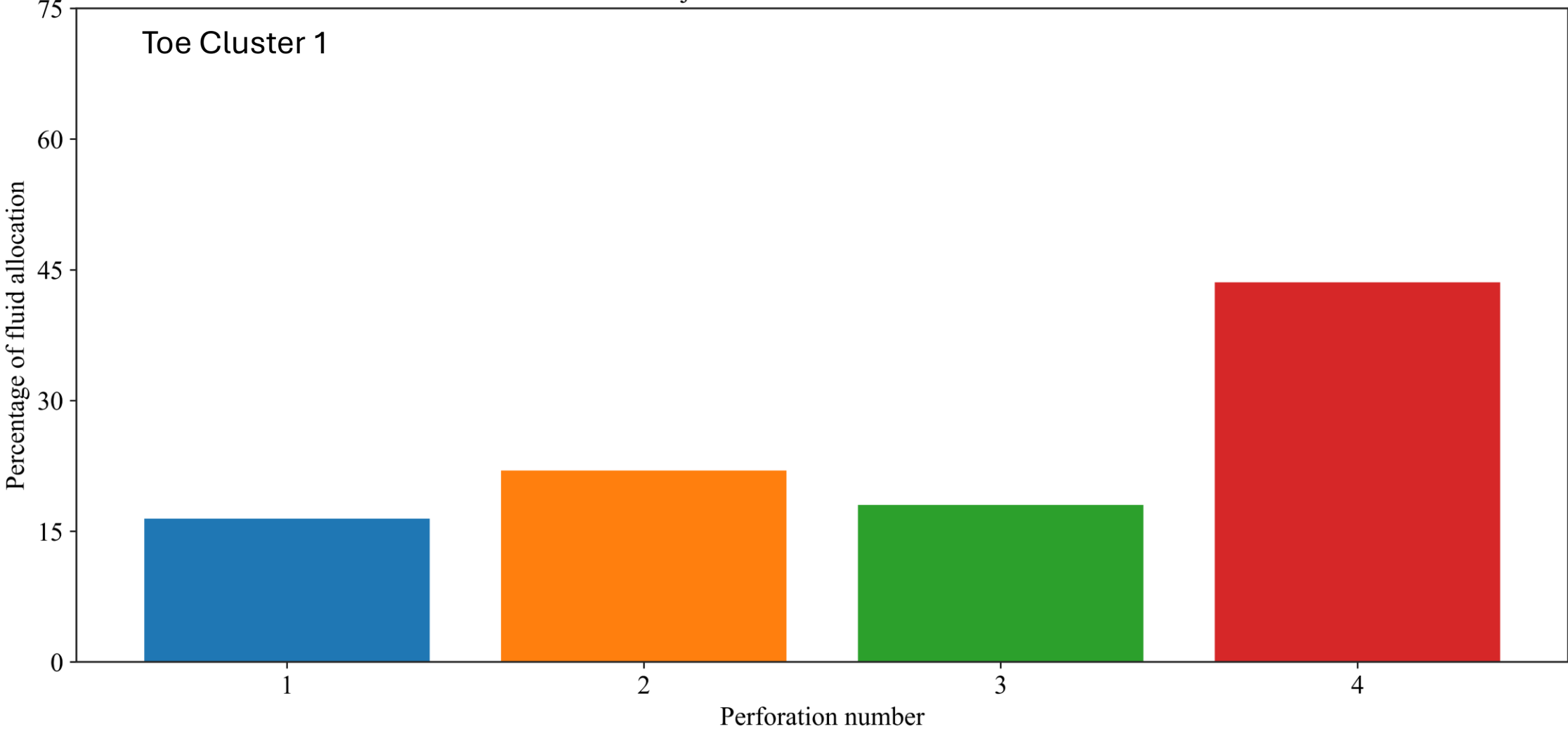
Stage 4: Apr 17, 12:02-13:12 (UTC Time)

Injection Allocation Plots

Stage 4: 2-8 Hz



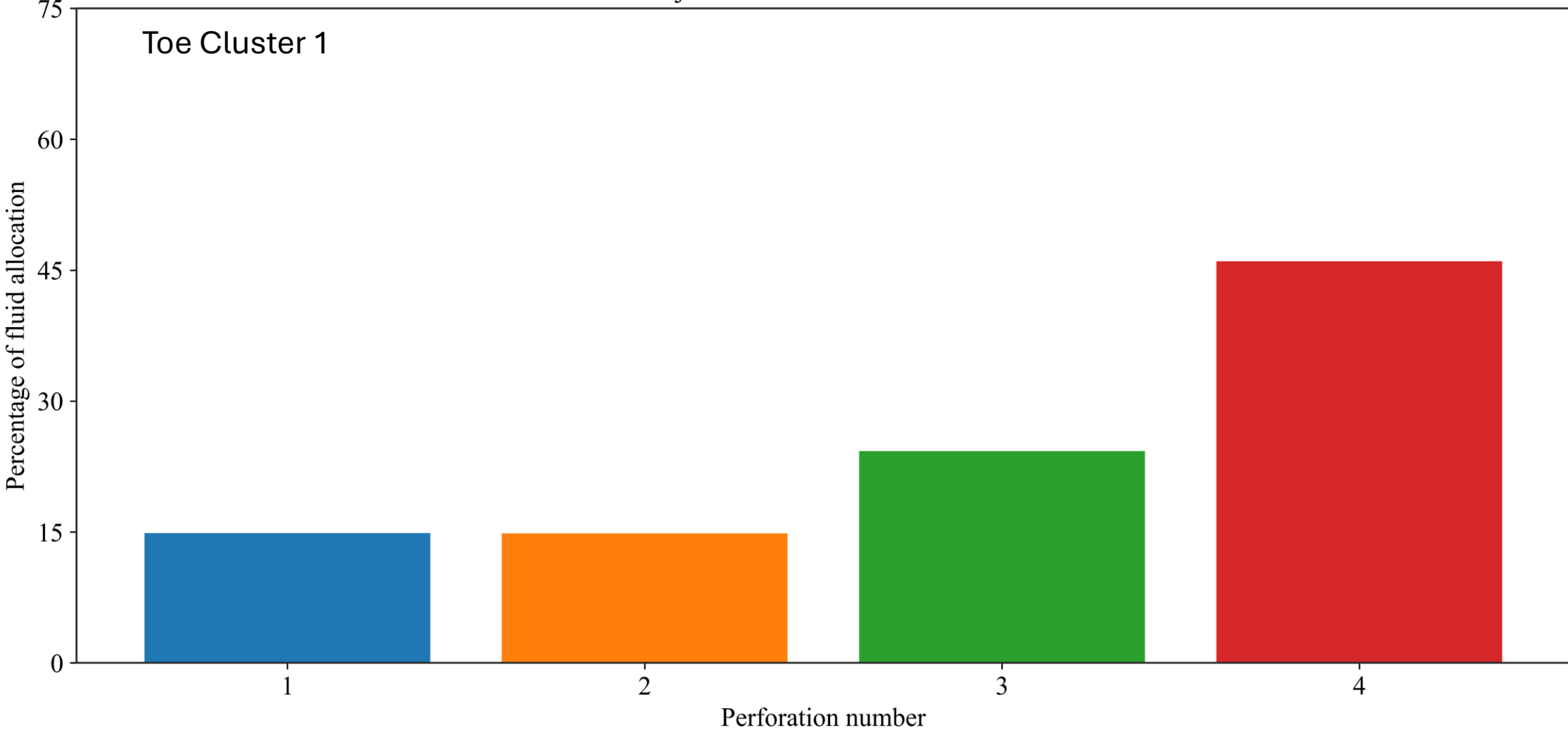
Fluid injection allocation for band: 2-8 Hz



Stage 4: 8-32 Hz



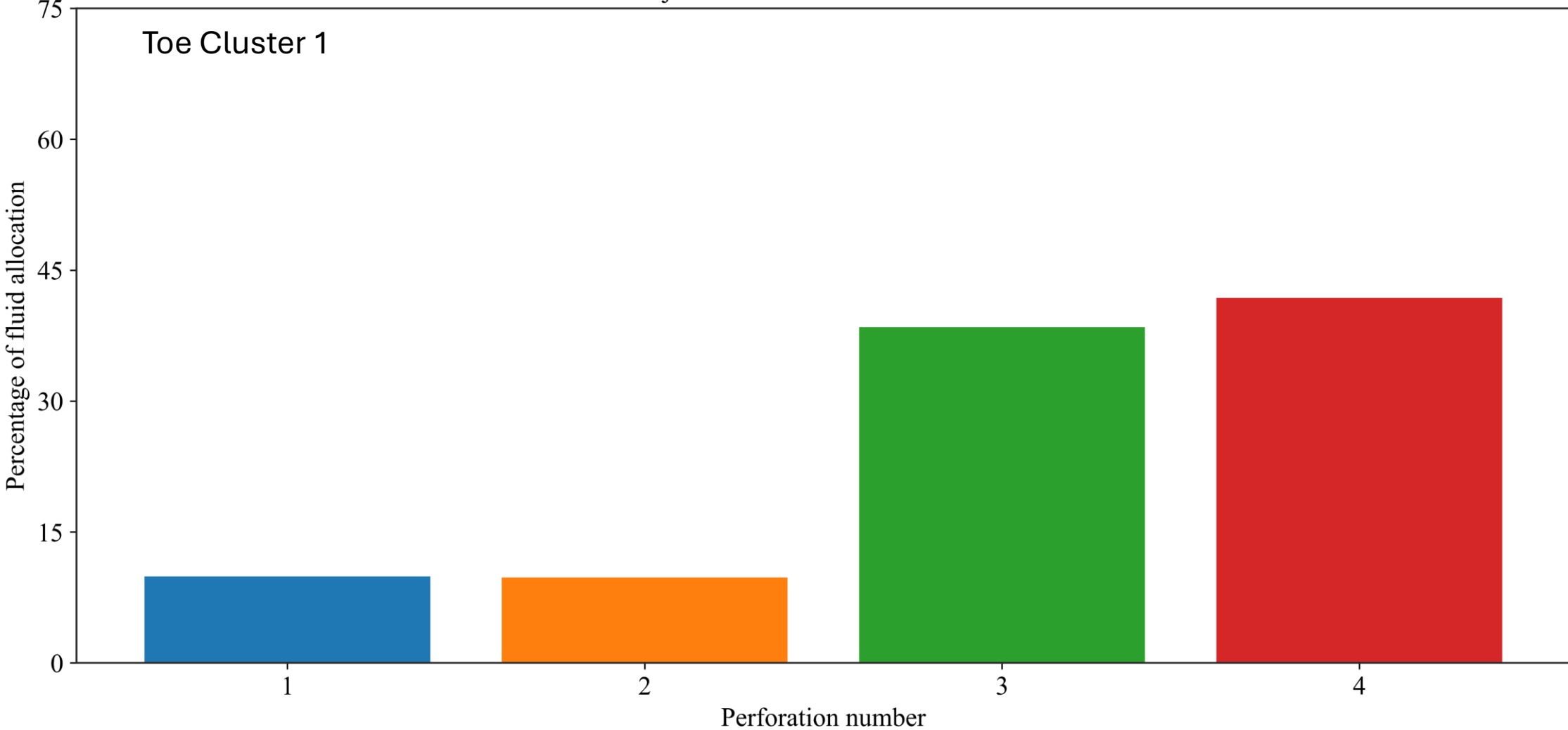
Fluid injection allocation for band: 8-32 Hz



Stage 4: 32-128 Hz



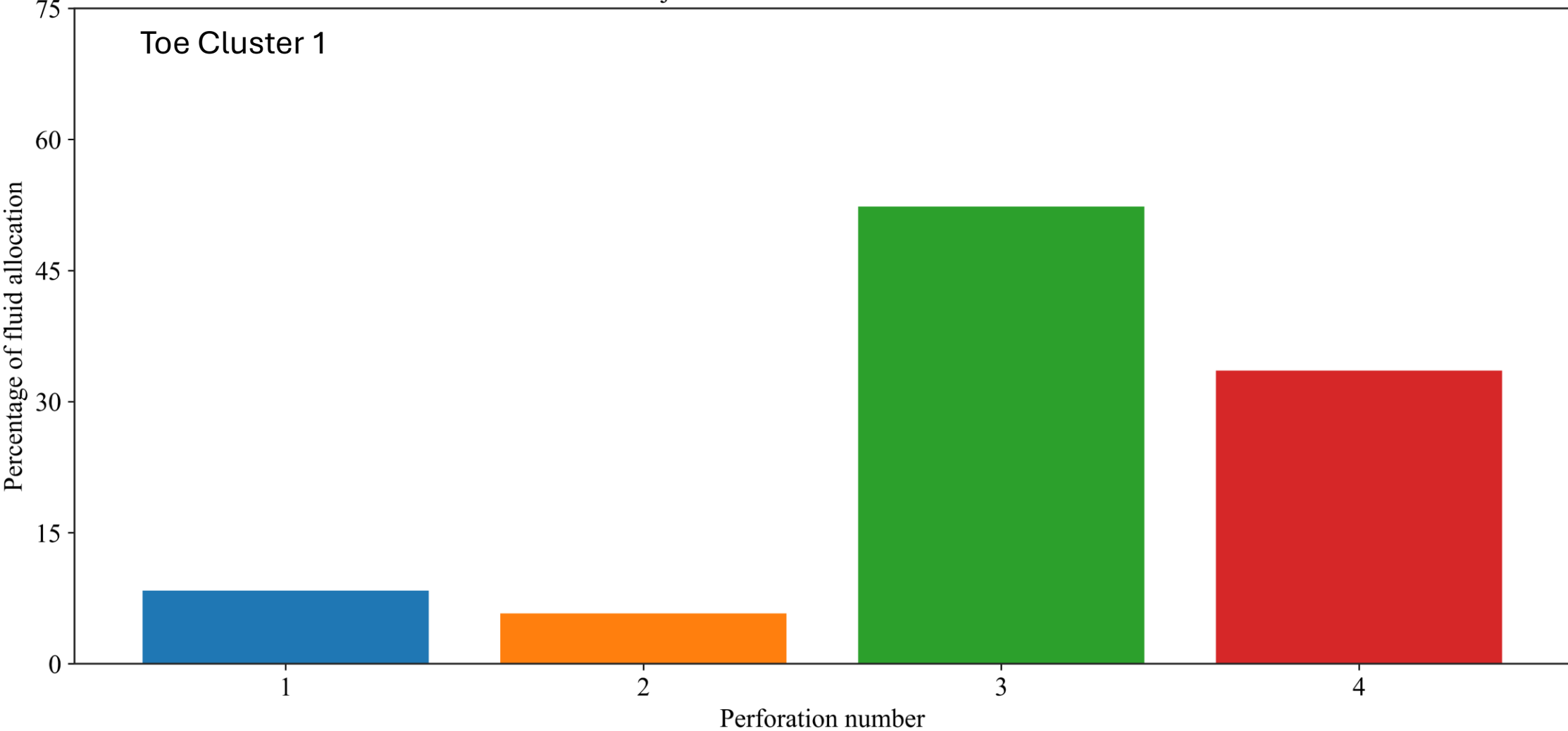
Fluid injection allocation for band: 32-128 Hz



Stage 4: 64-256 Hz



Fluid injection allocation for band: 64-256 Hz

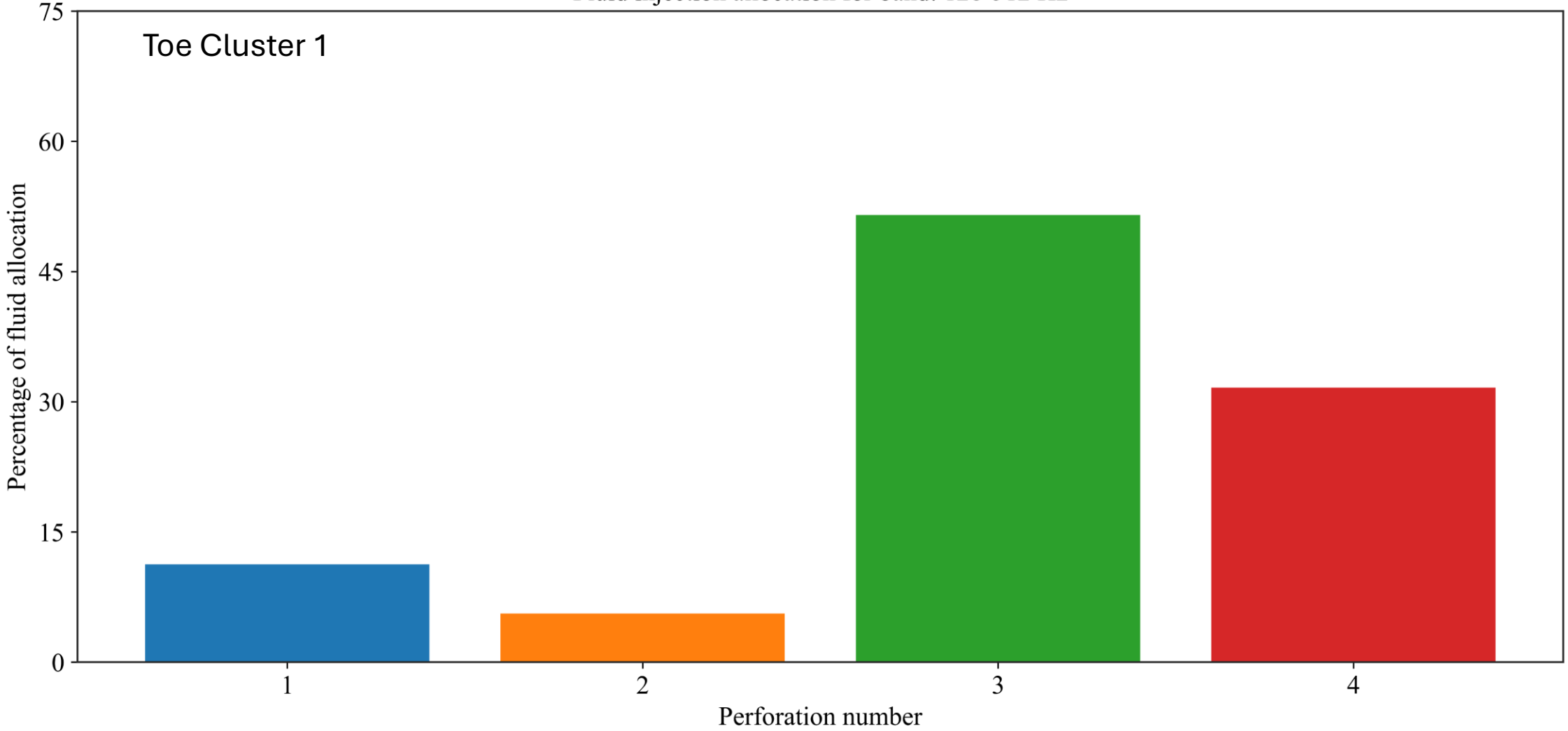


Toe Cluster 1

Stage 4: 128-512 Hz



Fluid injection allocation for band: 128-512 Hz

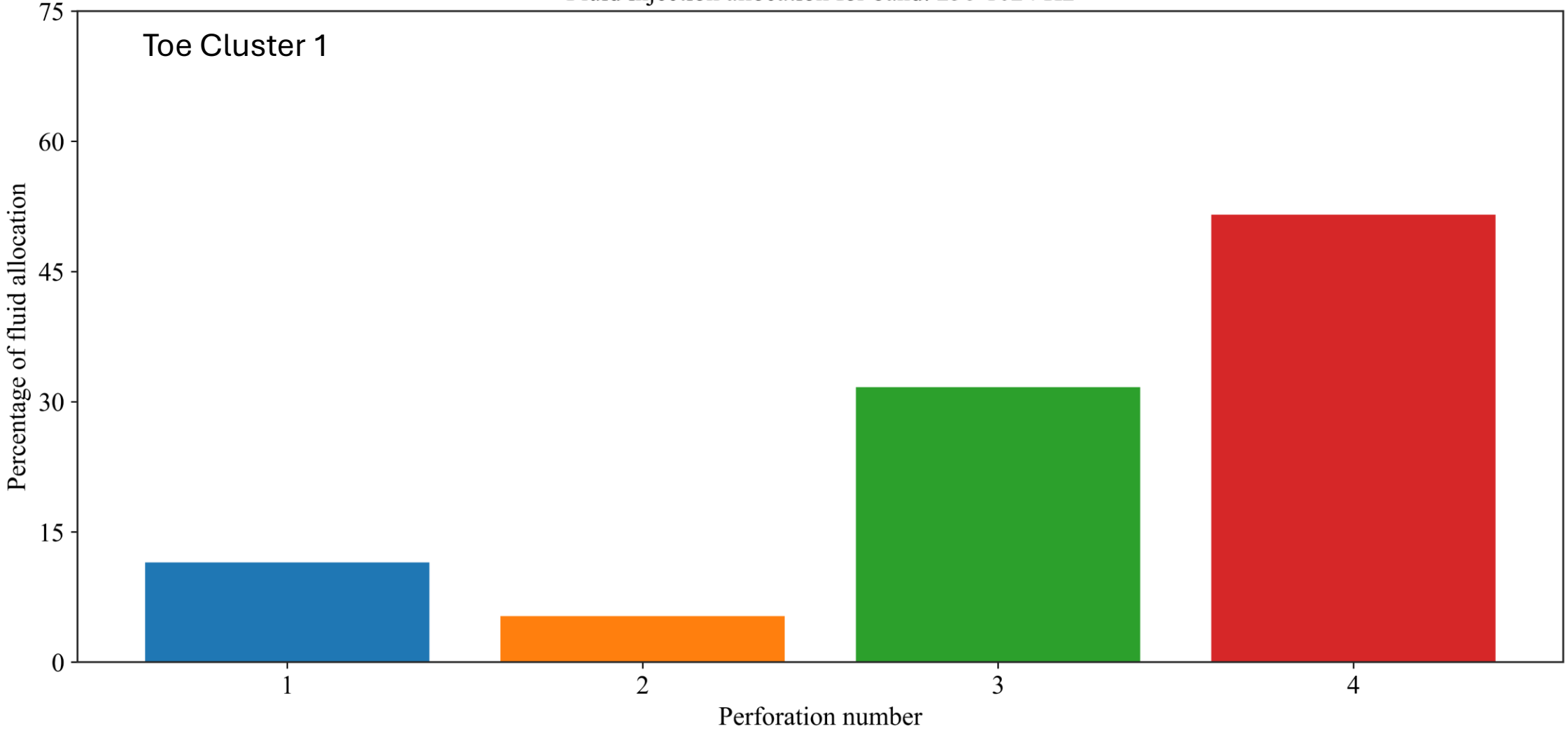


Toe Cluster 1

Stage 4: 256-1024 Hz



Fluid injection allocation for band: 256-1024 Hz

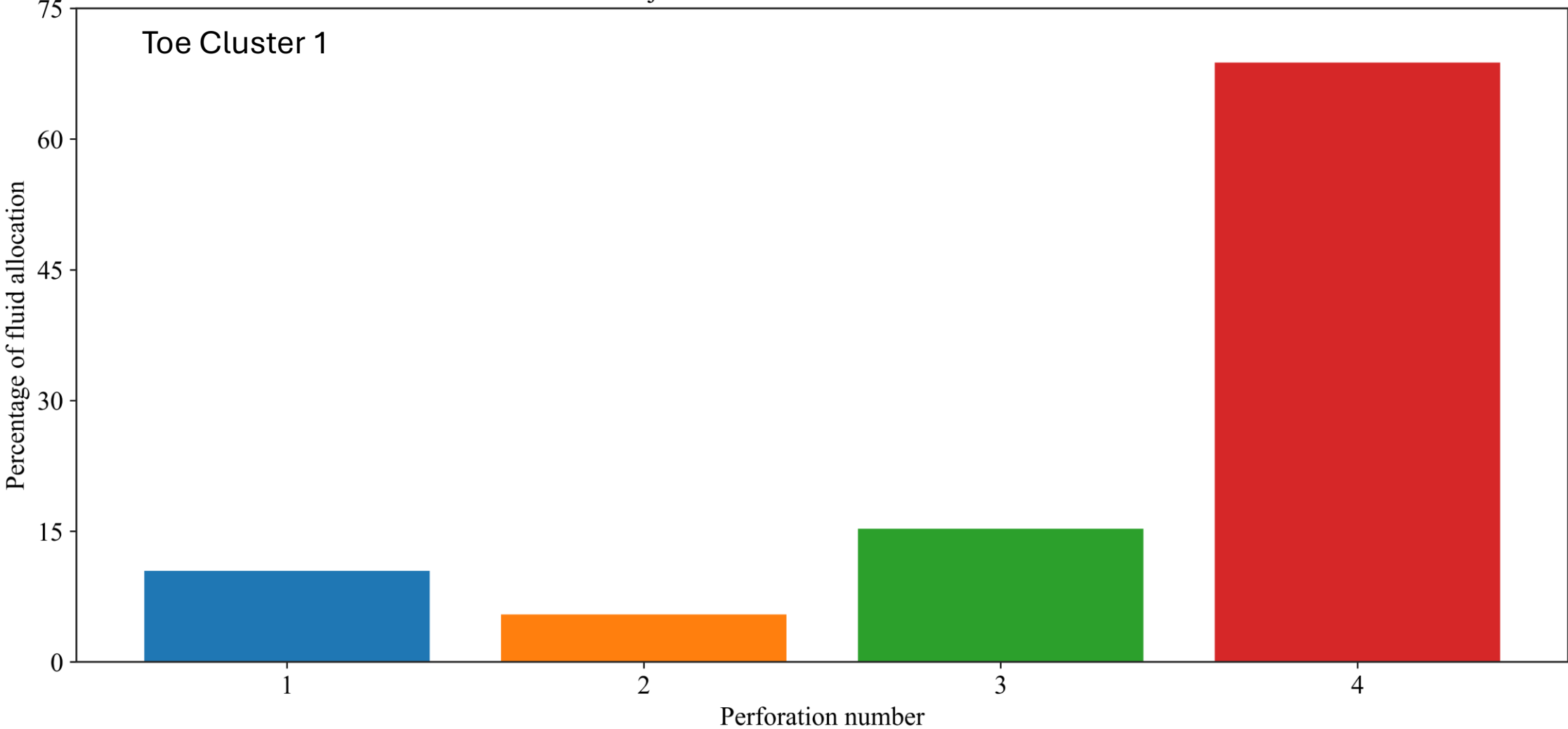


Toe Cluster 1

Stage 4: 512-2048 Hz



Fluid injection allocation for band: 512-2048 Hz

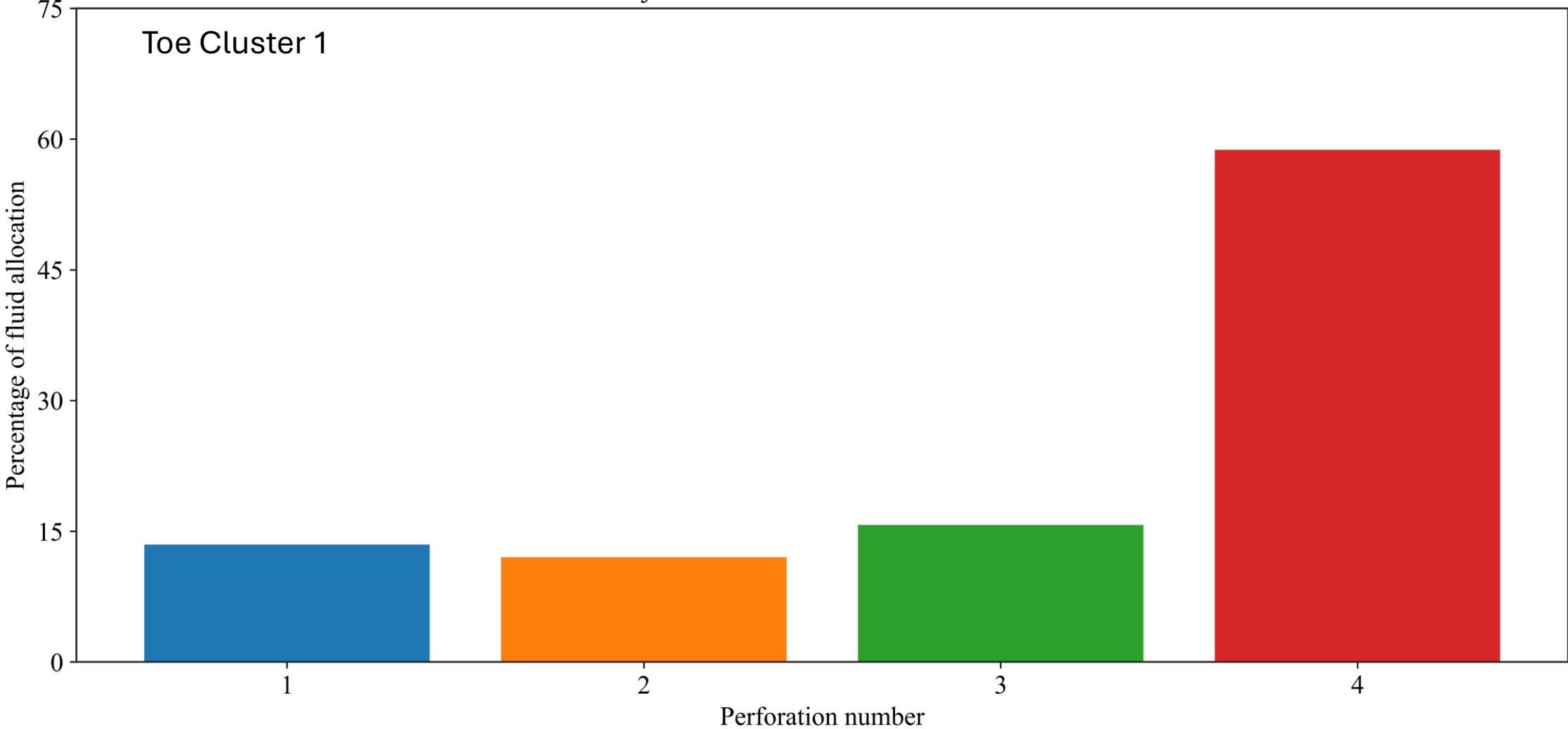


Toe Cluster 1

Stage 4: 1024-4096 Hz



Fluid injection allocation for band: 1024-4096 Hz



End of Technical Report and Contact Information

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