

# Algoritmos MMAS para ADTSP e MADTSP

João Pedro Schmitt

# Algoritmo MMAS\_MEM

- Implementado versão em Java do MMAS disponível no site:  
<http://www.aco-metaheuristic.org/>
- Algoritmo de memória proposto no BRACIS
- Algoritmos disponíveis em:
  - MADTSP -  
[https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS\\_MEM\\_MADTSP.java](https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS_MEM_MADTSP.java)
  - ADTSP -  
[https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS\\_MEM\\_ADTSP.java](https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS_MEM_ADTSP.java)

# Algoritmo US

- Convertido para Java a versão disponível em C++ proposta por Mavrovouniotis et al.: [https://mavrovouniotis.github.io/Codes/MMAS\\_US.zip](https://mavrovouniotis.github.io/Codes/MMAS_US.zip)
- Algoritmos disponíveis em:
  - MADTSP -  
[https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS\\_US\\_MADTSP.java](https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS_US_MADTSP.java)
  - ADTSP -  
[https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS\\_US\\_ADTSP.java](https://github.com/schmittjoaopedro/aco-vrp-framework/blob/master/src/main/java/com/github/schmittjoaopedro/algorithms/MMAS_US_ADTSP.java)

# Validação

- Para garantir o funcionamento dos algoritmos, foi desenvolvido um pseudo-framework com as diferentes variações do MMAS.
  - Implementado MMAS
  - Implementado MMAS\_MEM
  - Implementado US
  - Implementado DBGP
  - Implementado MVBS
- As execuções foram comparadas e validadas com os algoritmos originais.
- Testes para fixar o funcionamento.

# Validação do MMAS\_US Java vs C++

	KroA100		KroA150		KroA200	
	US C++	US Java	US C++	US Java	US C++	US Java
Frequencia = 10						
Magnitude = 0.1	22241	22249	27998	28027	31071	31190
Magnitude = 0.5	27212	27060	34509	34410	38807	38818
Magnitude = 0.75	31701	31818	40529	40351	45597	45735
Frequencia = 100						
Magnitude = 0.1	22145	22233	27820	27932	30841	30924
Magnitude = 0.5	26641	26360	33733	33420	37890	37905
Magnitude = 0.75	30881	30577	39463	38857	44562	44076

# Testes

MMAS_MEM_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_mem_moving_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_10	7 s 348 ms	32 s 201 ms
MMAS_MEM_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_mem_moving_asymmetric_dynamic_tsp_kroA150_with_seed_1_mag_0_1_freq_10	10 s 18 ms	
MMAS_MEM_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_mem_moving_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_100	3 s 82 ms	
MMAS_MEM_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_mem_moving_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_75_freq_10		
MMAS_MEM_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_mem_moving_asymmetric_dynamic_tsp_kroA150_with_seed_1_mag_0_1_freq_100	7 s 753 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA200_with_seed_1_mag_0_75_freq_10	515 ms	1 s 375 ms
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_5_freq_100	47 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_75_freq_100	390 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_100	0 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_75_freq_10	95 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	few_vertices_to_execute_us_test		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_unstringing_stringing_kroA200_route_parity		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_unstringing_stringing_kroA100_route_parity		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_unstringing_stringing_kroA200_route_in_order_asc		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	eternal_loop_test		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	eternal_loop_test_due_to_double_usage		
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_unstringing_stringing_kroA150_route_in_order_asc	172 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_unstringing_stringing_kroA150_route_parity	156 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_100	32 s 555 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_75_freq_100	4 s 501 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_100	3 s 712 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_75_freq_10	4 s 608 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA100_with_seed_1_mag_0_1_freq_10	4 s 237 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA150_with_seed_1_mag_0_1_freq_10	8 s 322 ms	
MMAS_US_MADTSP_Test (com.github.schmittjoaopedro)	test_mmas_asymmetric_dynamic_tsp_kroA150_with_seed_1_mag_0_1_freq_100	7 s 175 ms	

# Parâmetros dos testes

- DBGP: LB = 0; UB = 2;
- Rho
  - US = 0.8
  - US\_MEM = 0.8-0.02
  - MEM = 0.8-0.02
- Alpha = 1; Beta = 5; Ants = 50; NN = 20;
- Memória
  - Size = 4
  - Mutation = 0.01
  - Immigration Ratio = 0.4
- 30 execuções cada algoritmo
- 1.000 iterações

**MMAS\_MEM vs MMAS\_US vs  
MMAS\_MEM\_US para Moving ADTSP**

Frequênciā = 10

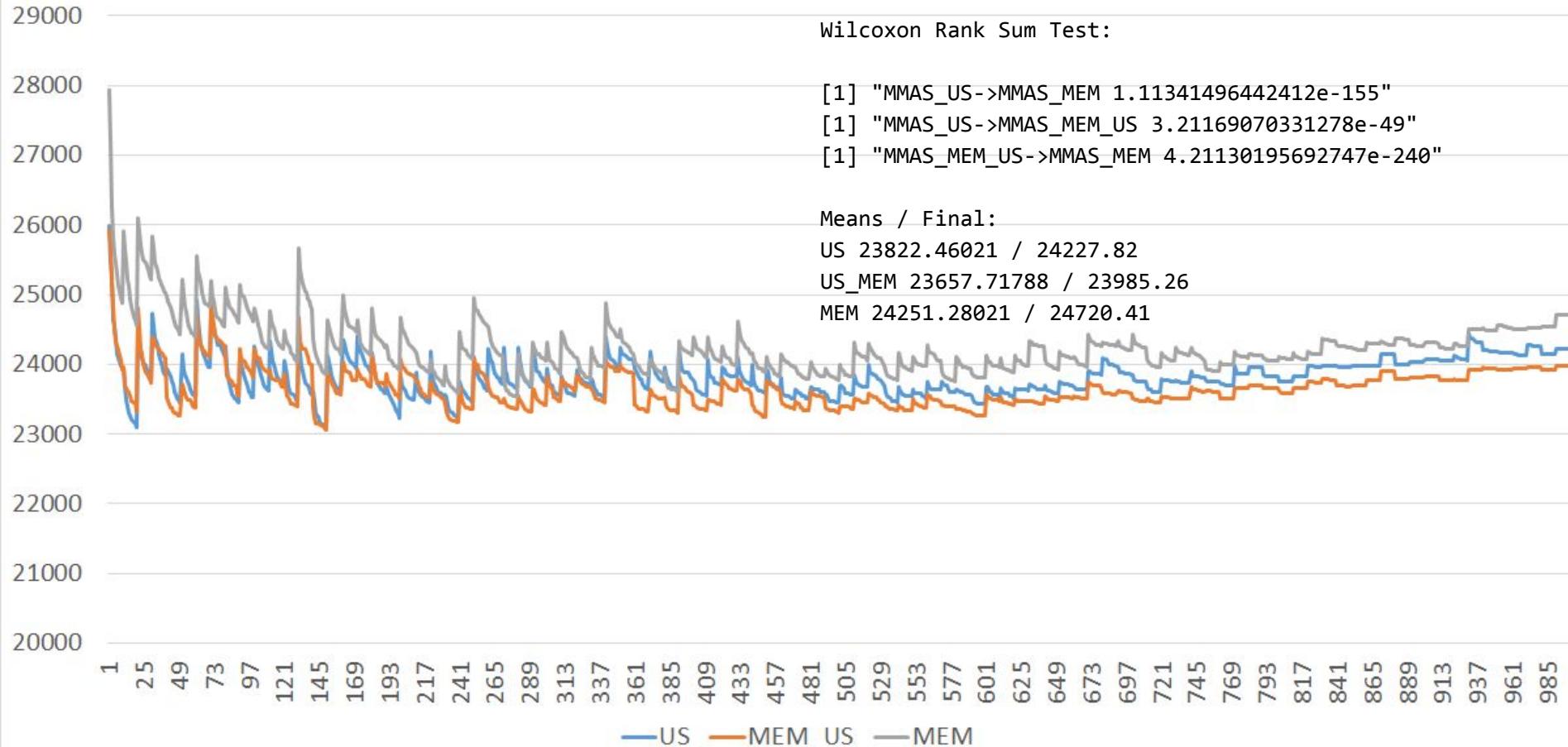
# KroA100 - freq 10 - mag 0.1

Wilcoxon Rank Sum Test:

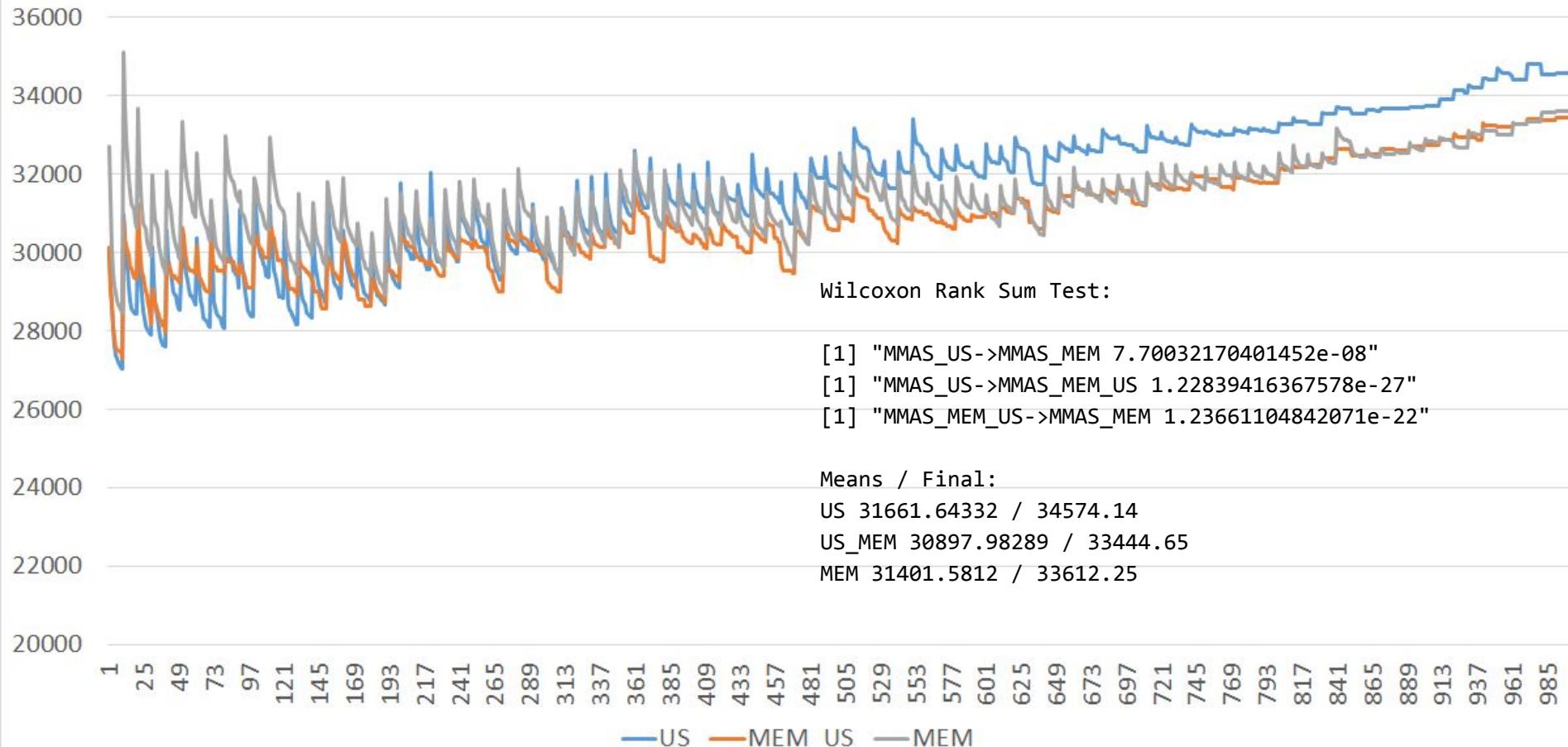
```
[1] "MMAS_US->MMAS_MEM 1.11341496442412e-155"  
[1] "MMAS_US->MMAS_MEM_US 3.21169070331278e-49"  
[1] "MMAS_MEM_US->MMAS_MEM 4.21130195692747e-240"
```

Means / Final:

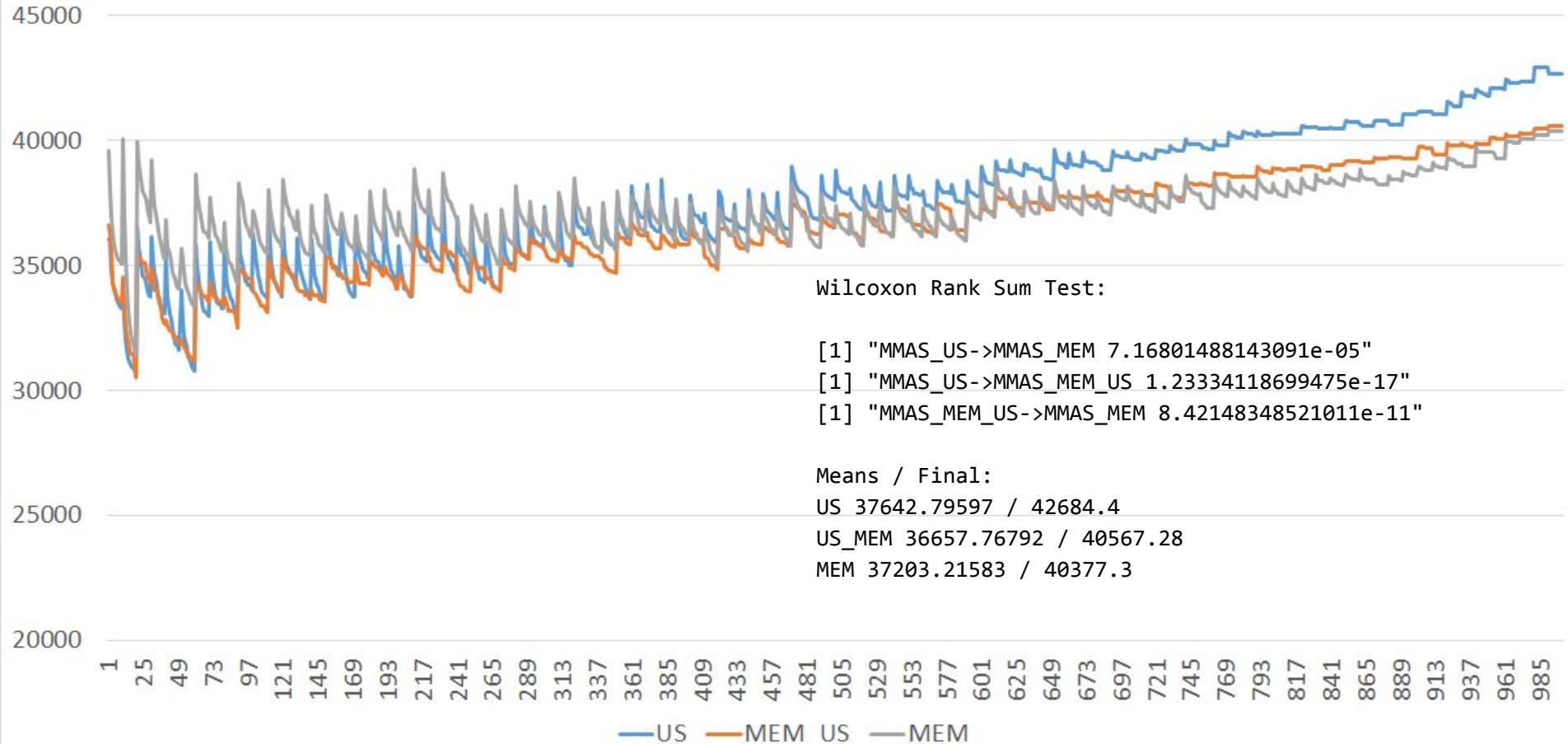
US 23822.46021 / 24227.82  
US\_MEM 23657.71788 / 23985.26  
MEM 24251.28021 / 24720.41



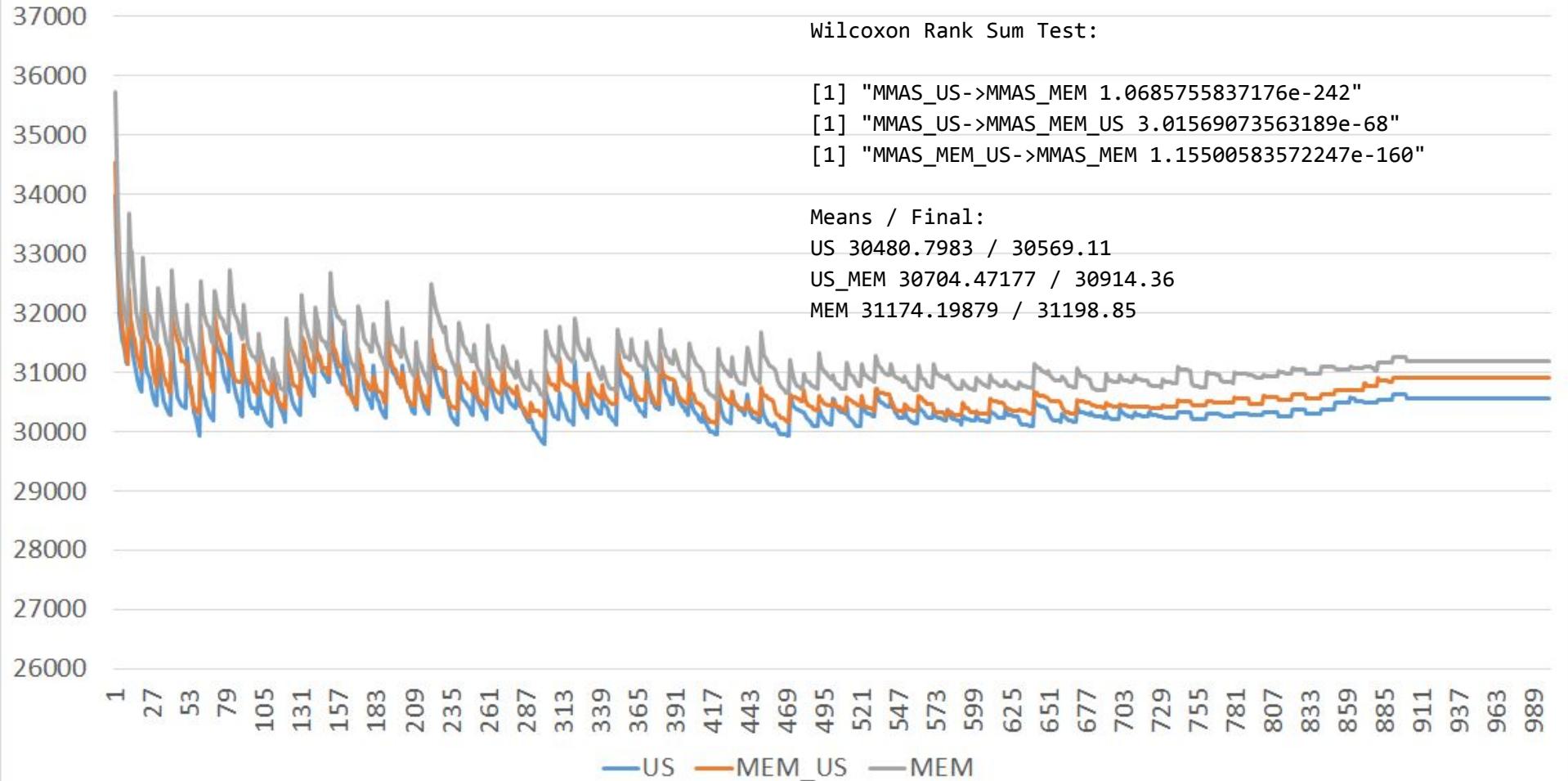
# KroA100 - freq 10 - mag 0.5



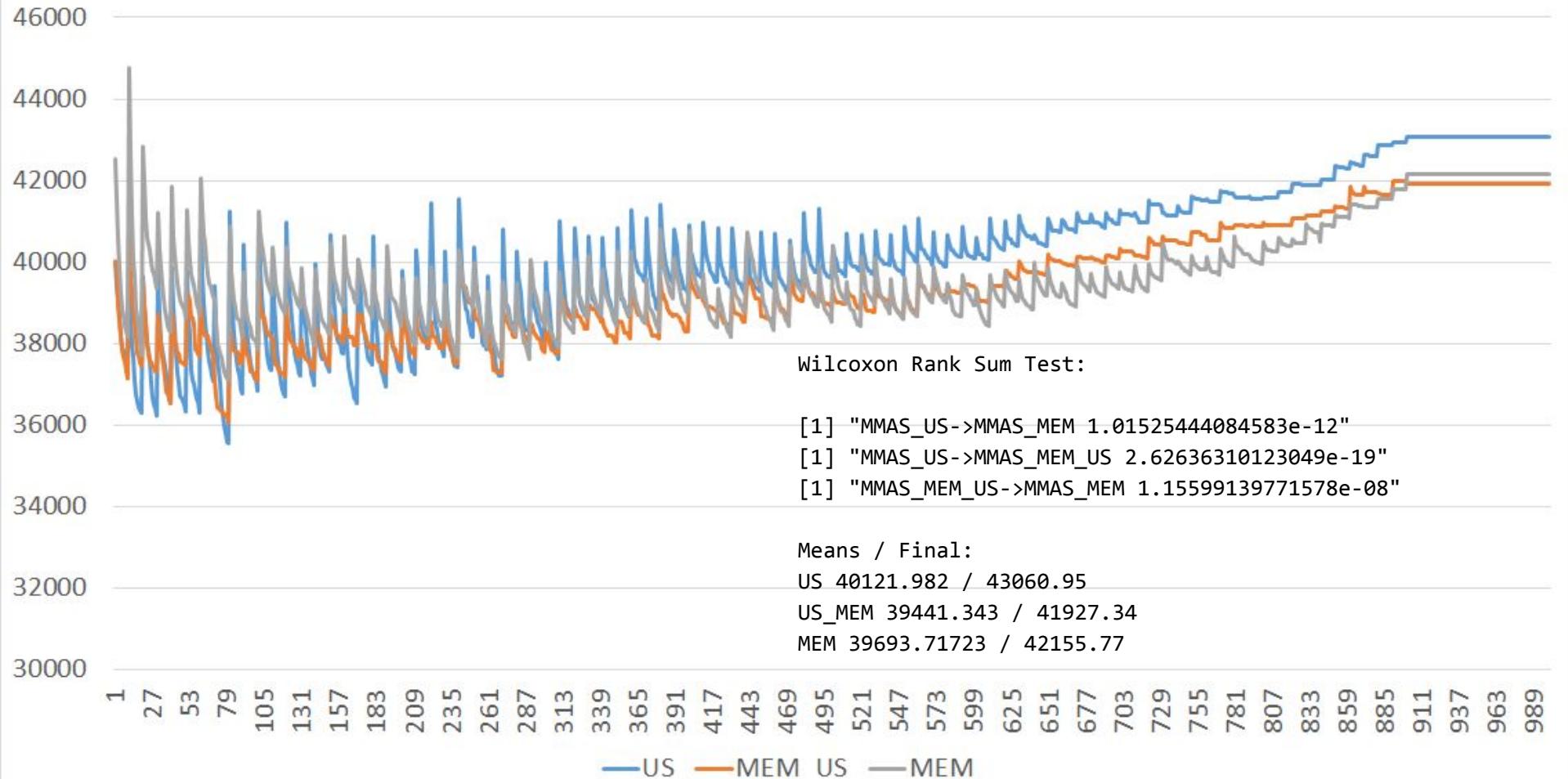
# KroA100 - freq 10 - mag 0.75



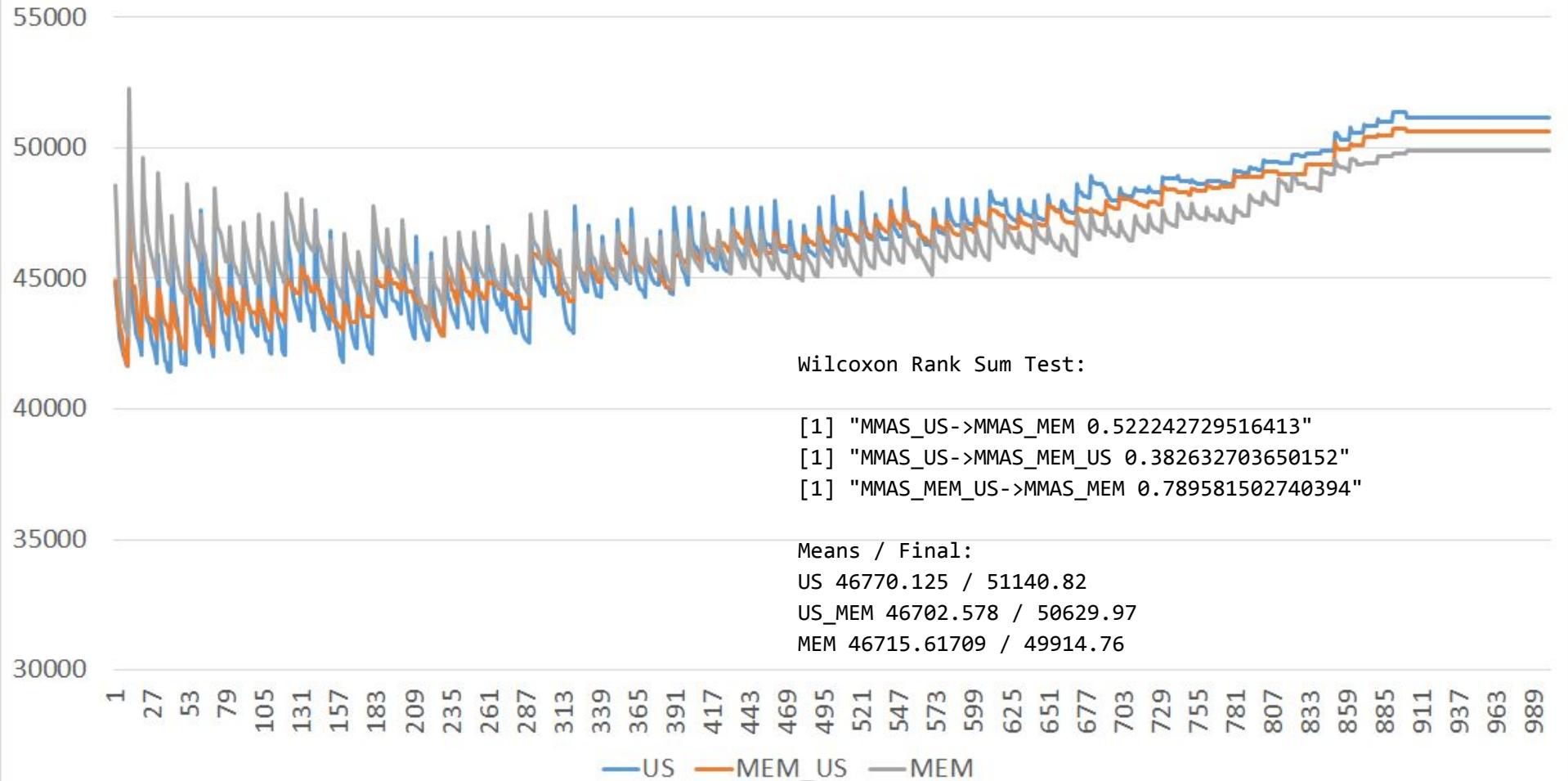
# KroA150 - freq 10 - mag 0.1



# KroA150 - freq 10 - mag 0.5



# KroA150 - freq 10 - mag 0.75



# KroA200 - freq 10 - mag 0.1

Wilcoxon Rank Sum Test:

```
[1] "MMAS_US->MMAS_MEM 2.59851954962938e-128"  
[1] "MMAS_US->MMAS_MEM_US 2.75268405233992e-72"  
[1] "MMAS_MEM_US->MMAS_MEM 8.80269718341246e-89"
```

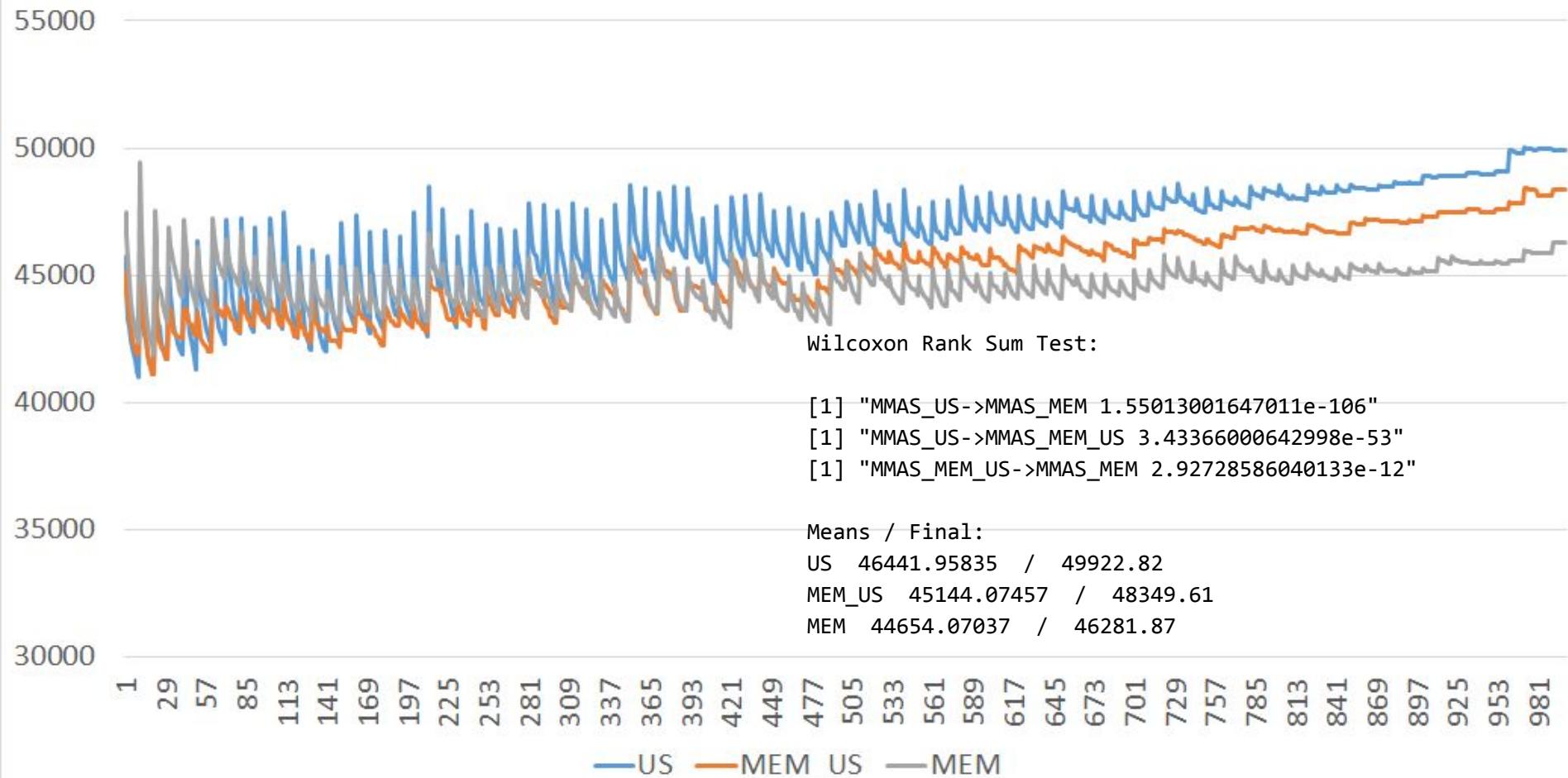
Means / Final:

US 35264.32887 / 35465.25  
MEM\_US 35017.78567 / 35065.46  
MEM 34618.47496 / 34226.15

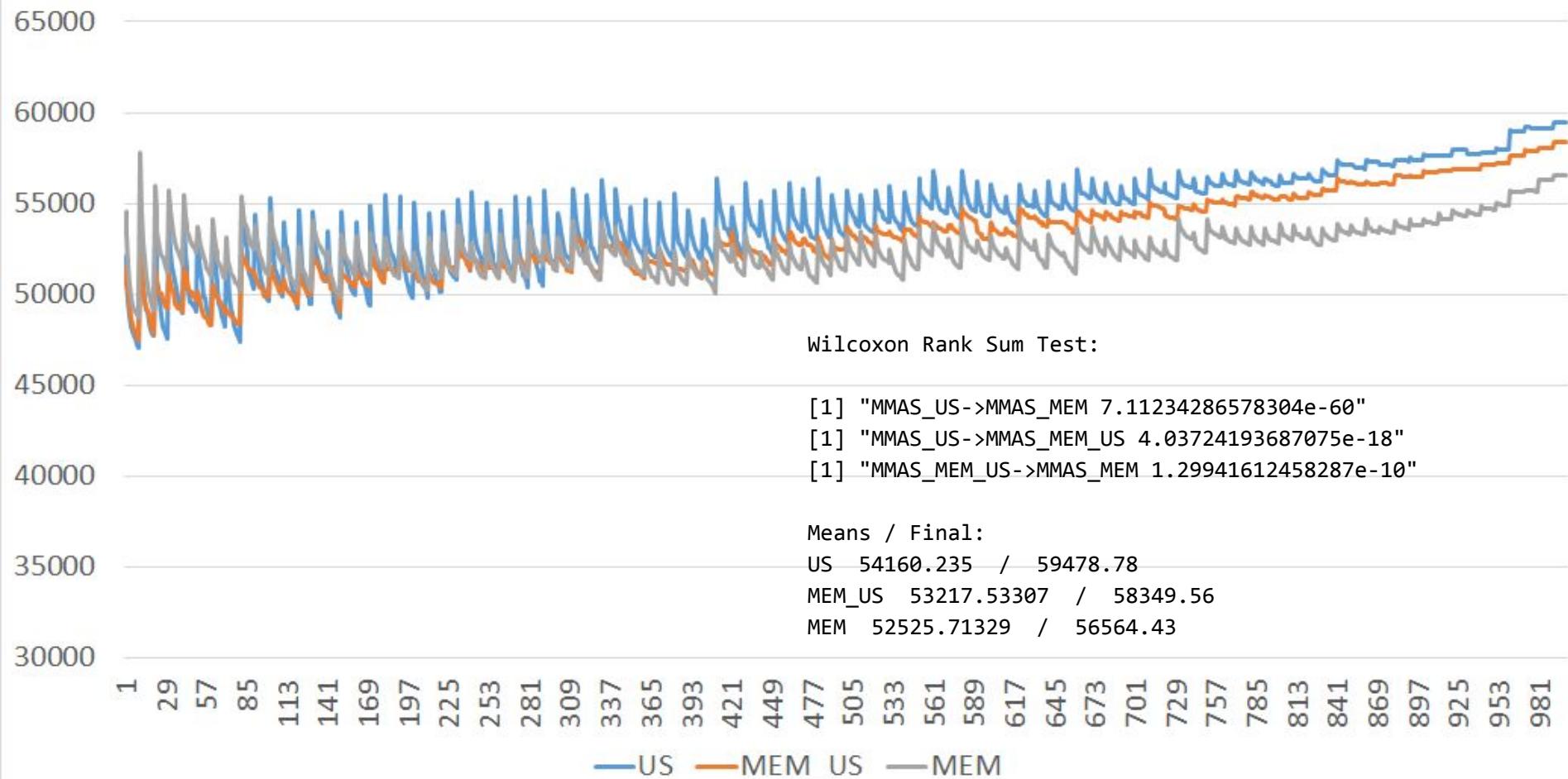
1 29 57 85 113 141 169 197 225 253 281 309 337 365 393 421 449 477 505 533 561 589 617 645 673 701 729 757 785 813 841 869 897 925 953 981

— US — MEM\_US — MEM

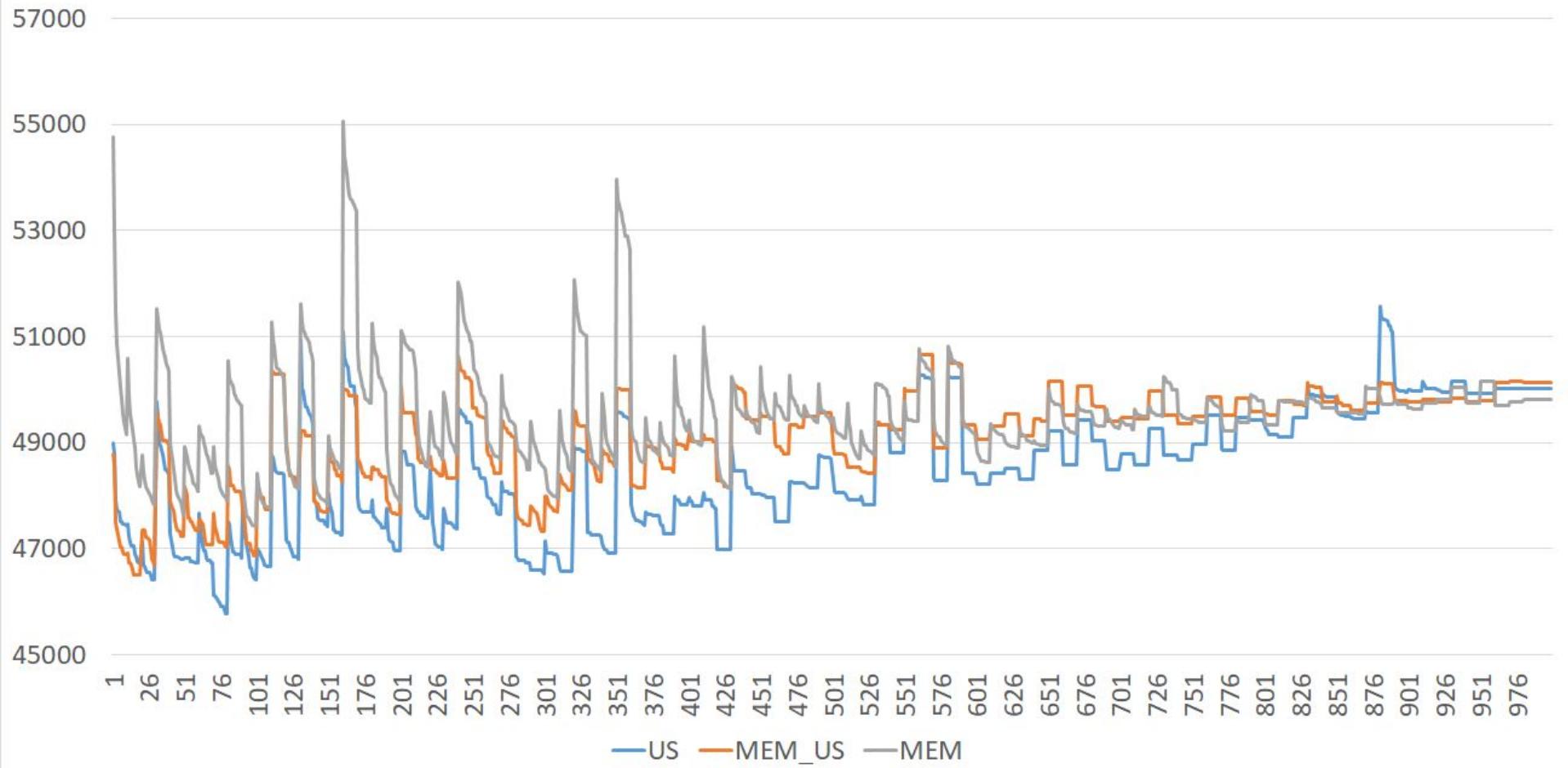
# KroA200 - freq 10 - mag 0.5



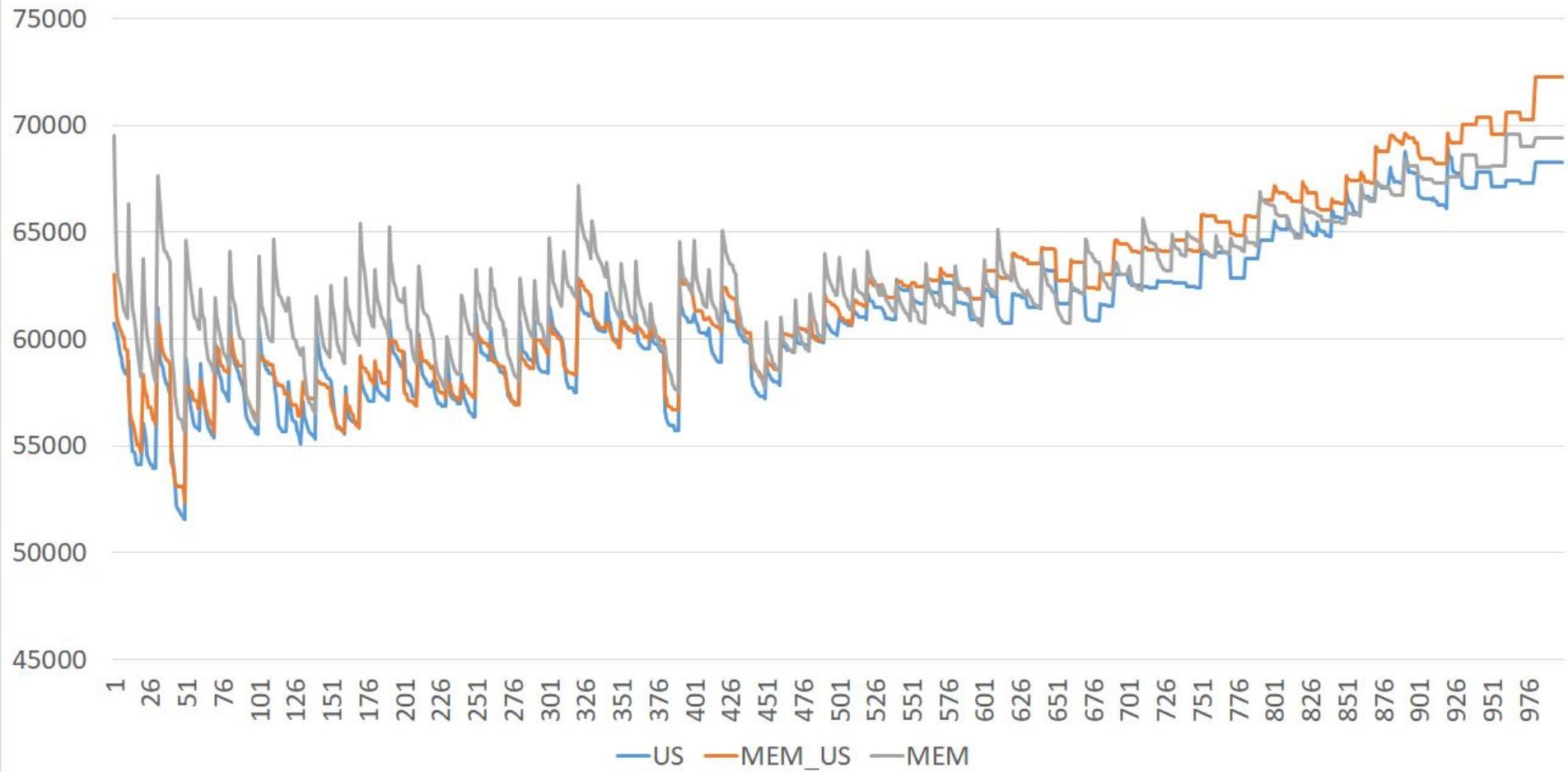
# KroA200 - freq 10 - mag 0.75



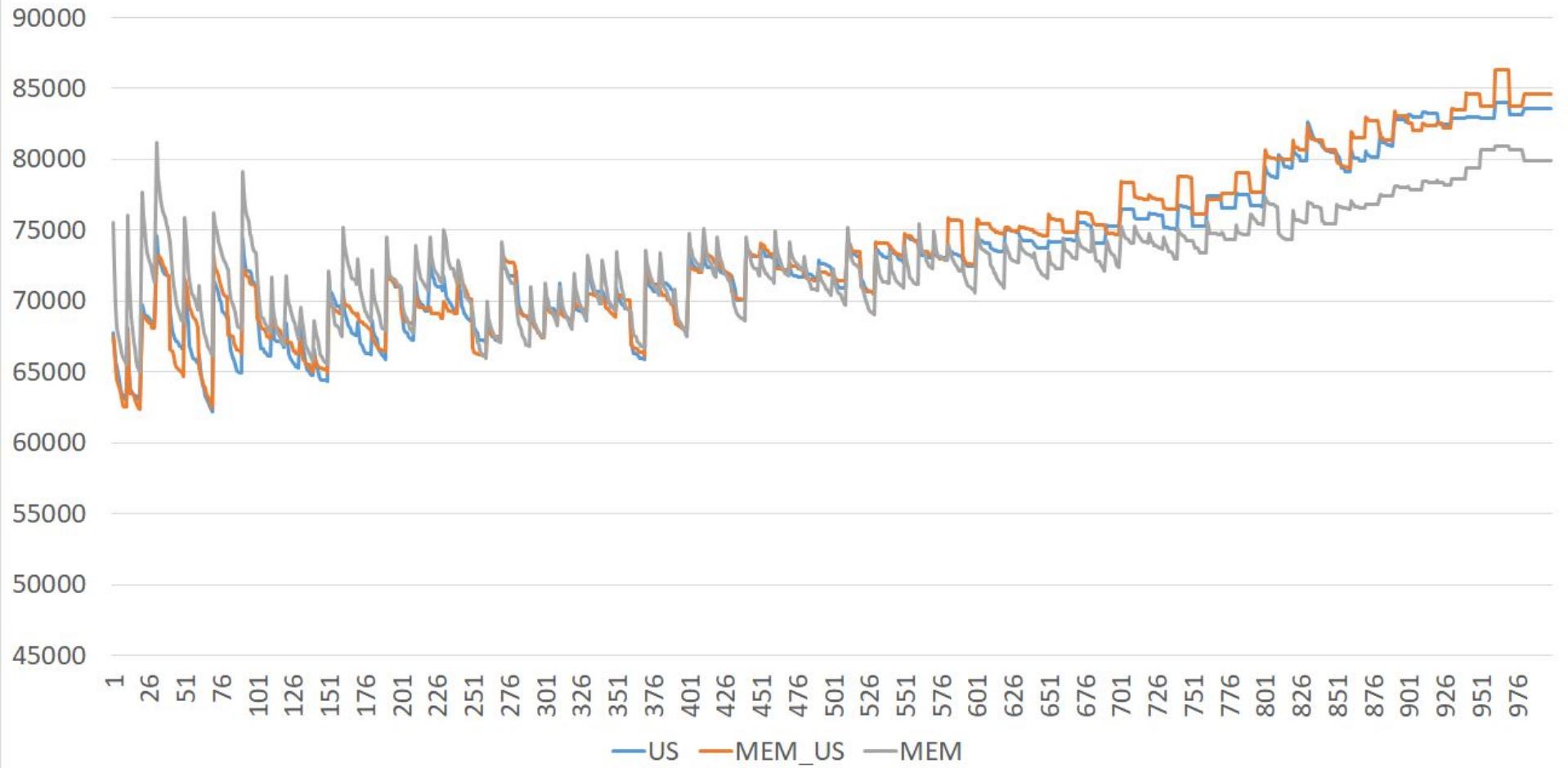
# Joinville 46 - freq 10 - mag 0.1



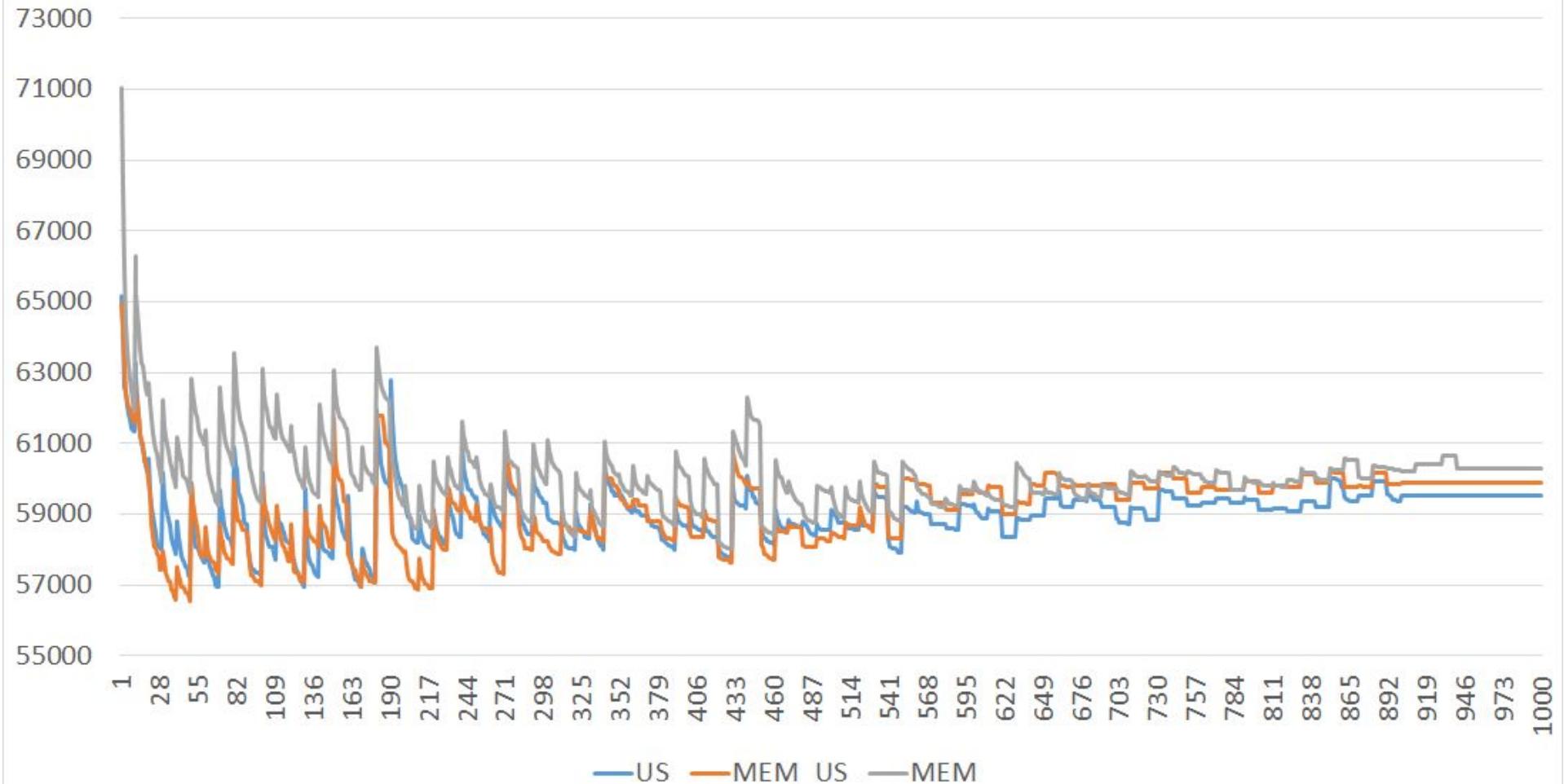
# Joinville 46 - freq 10 - mag 0.5



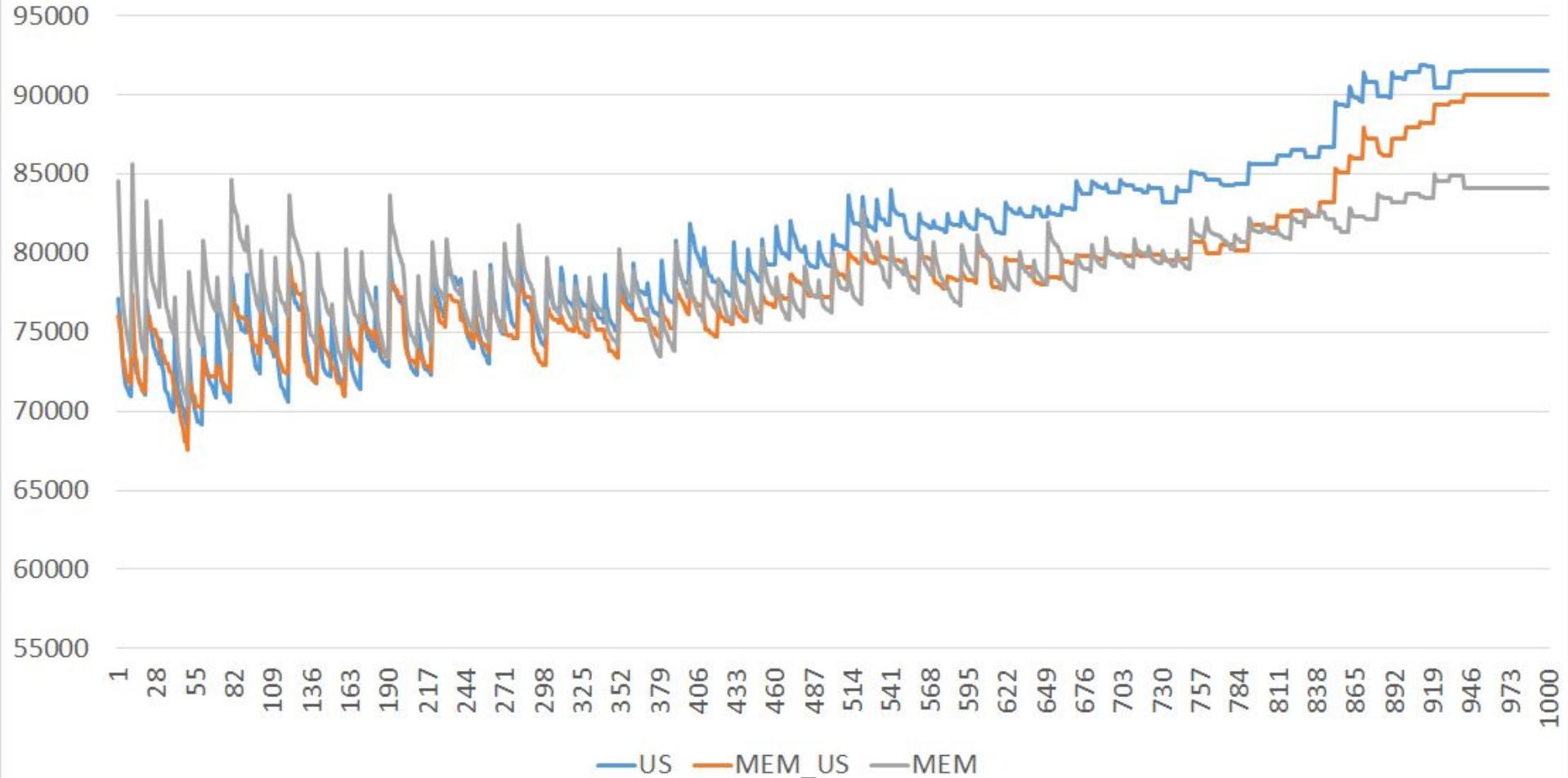
# Joinville 46 - freq 10 - mag 0.75



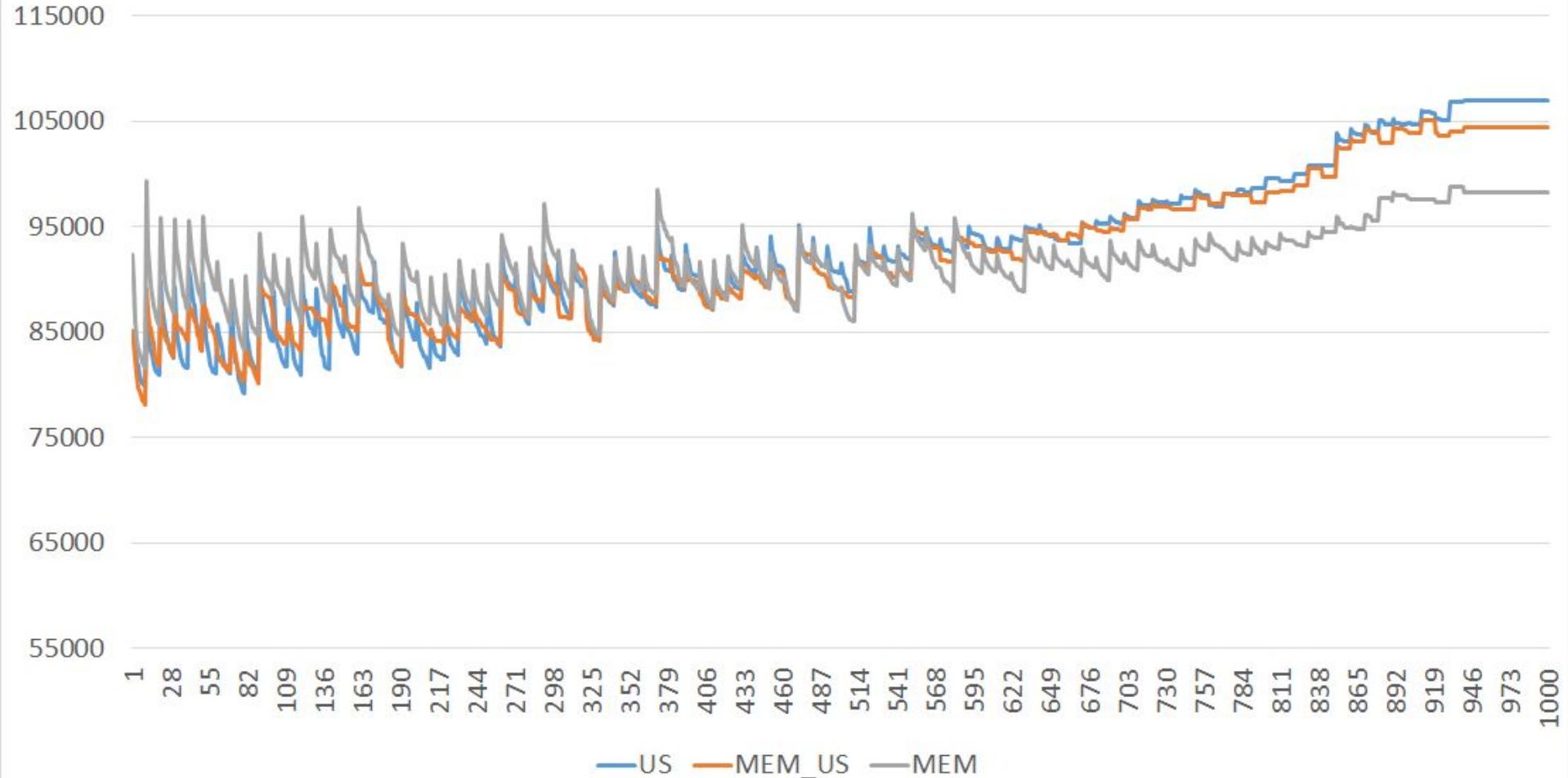
# Joinville 78 - freq 10 - mag 0.1



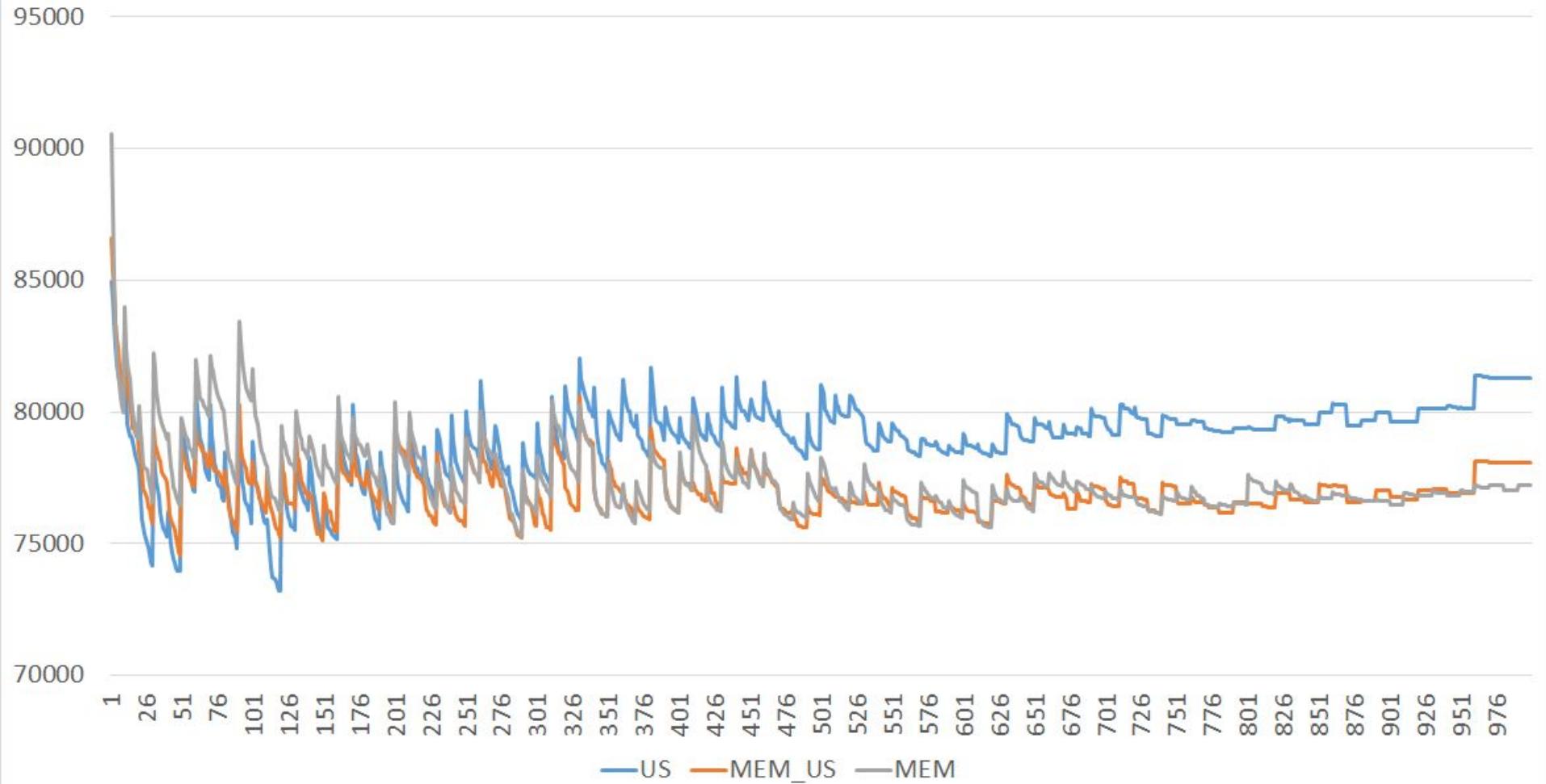
# Joinville 78 - freq 10 - mag 0.5



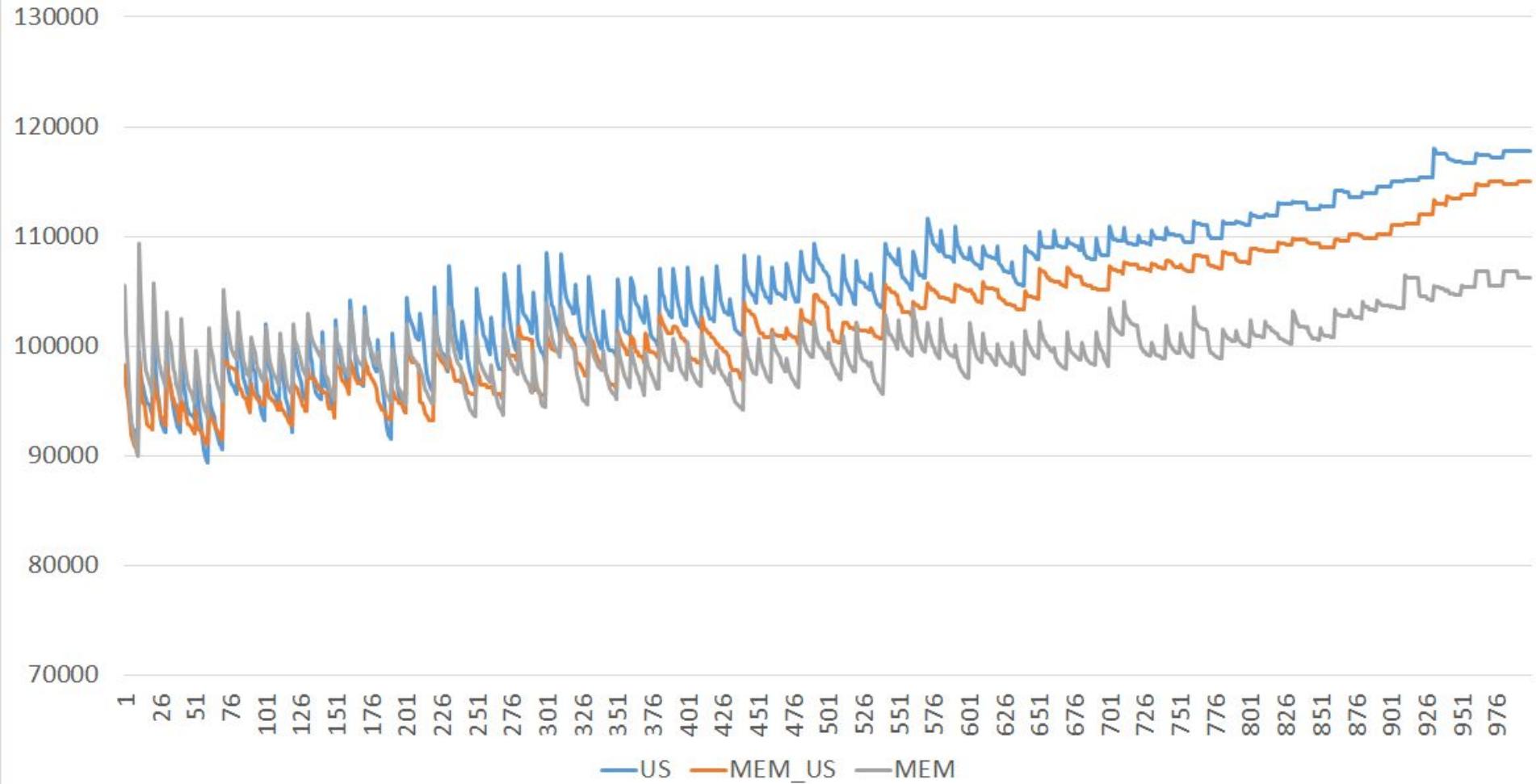
# Joinville 78 - freq 10 - mag 0.75



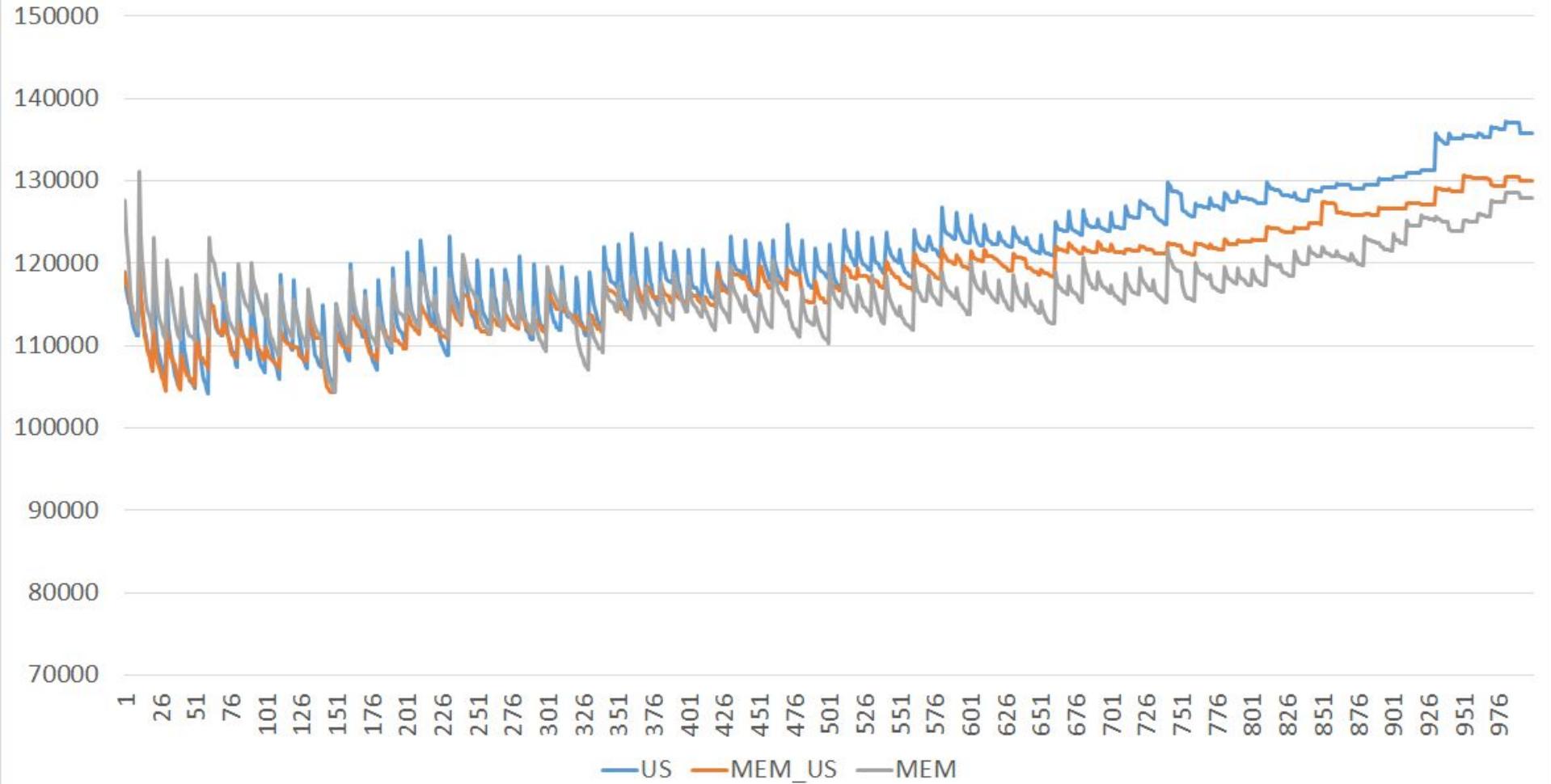
# Joinville 125 - freq 10 - mag 0.1



# Joinville 125 - freq 10 - mag 0.5

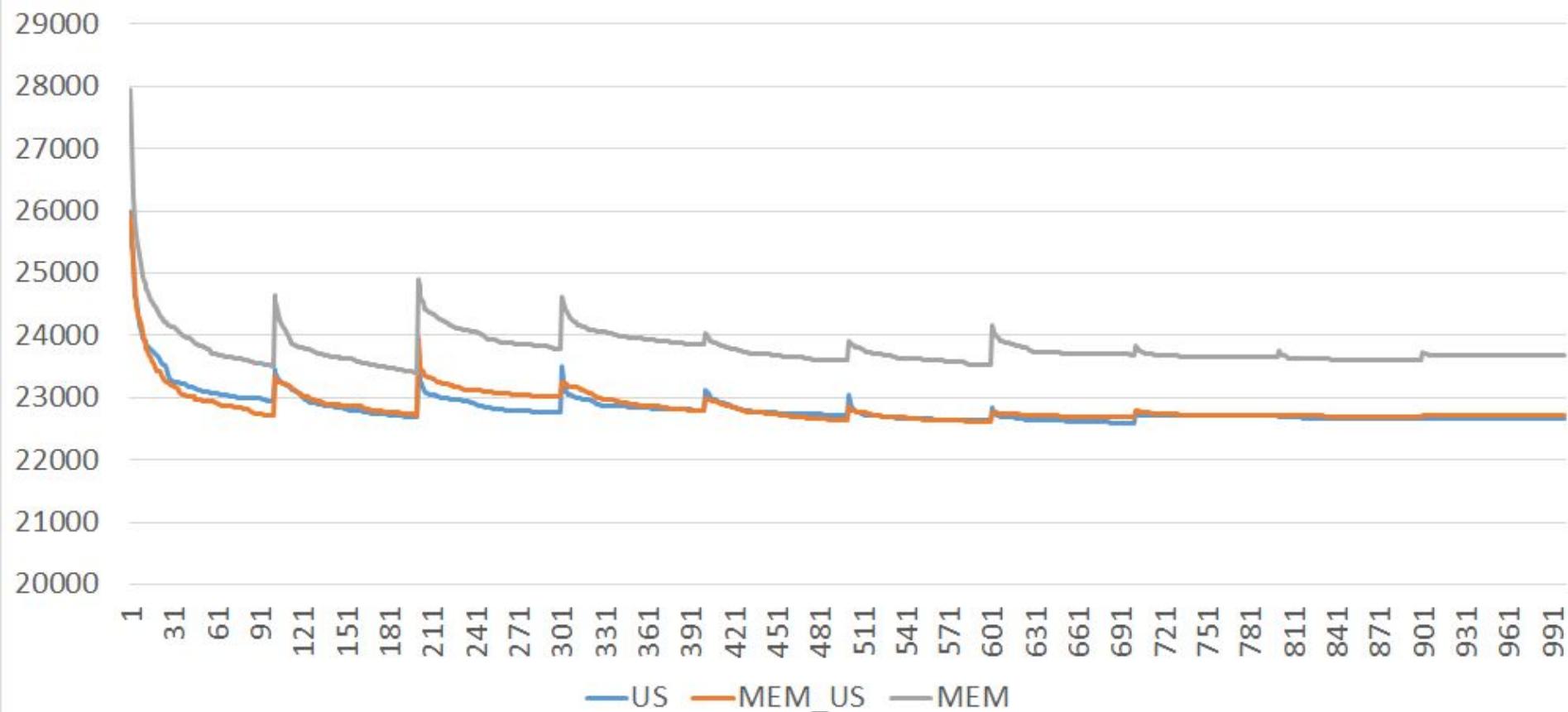


# Joinville 125 - freq 10 - mag 0.75

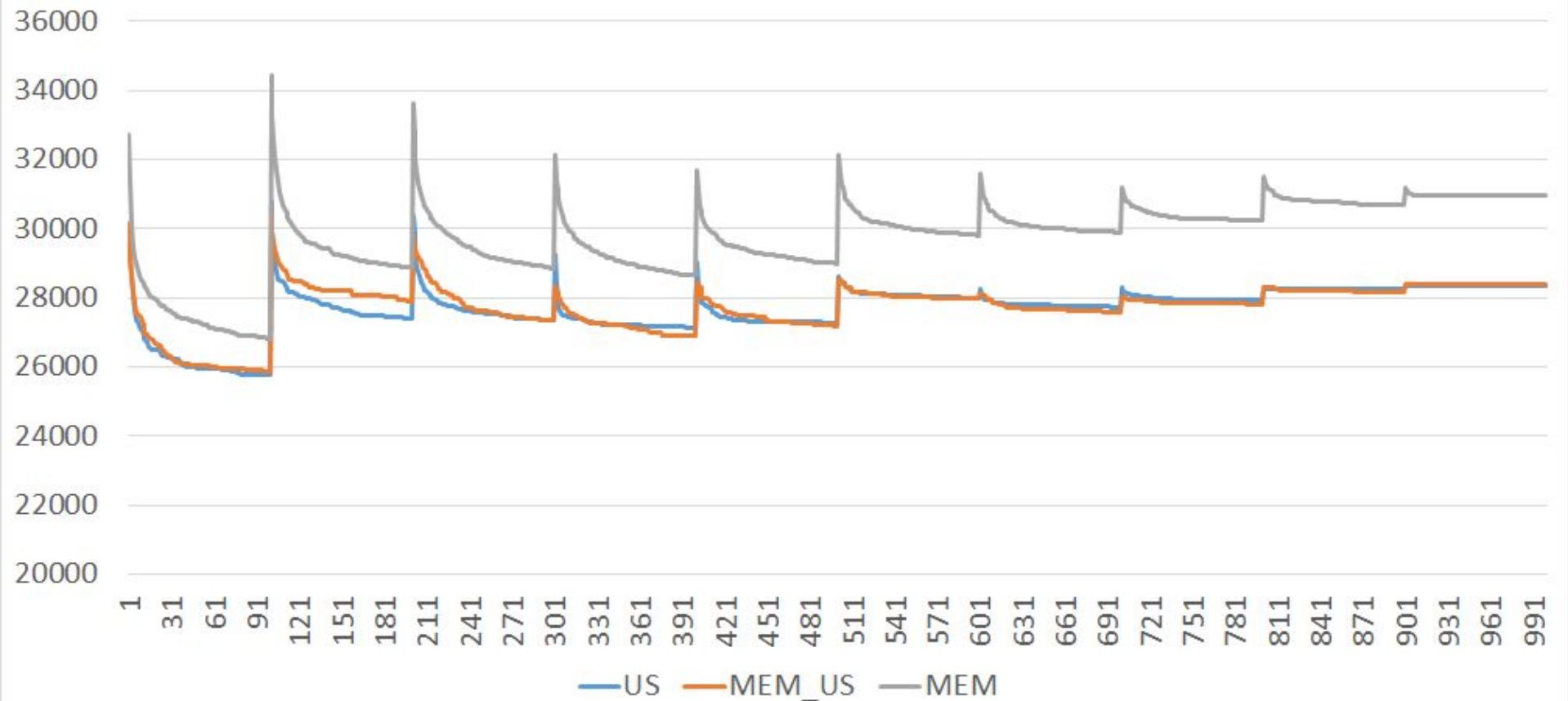


Frequênciā = 100

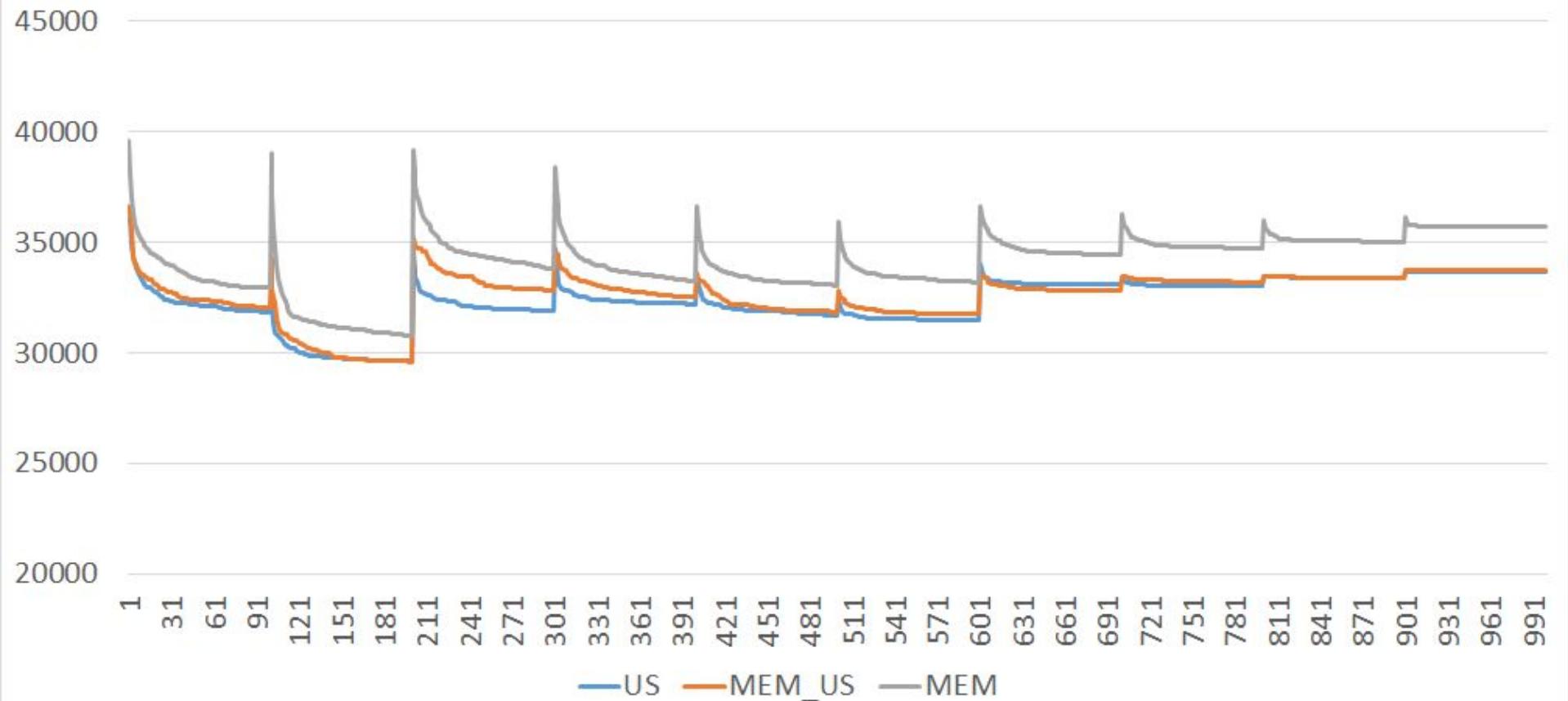
# KroA100 - freq 100 - mag 0.1



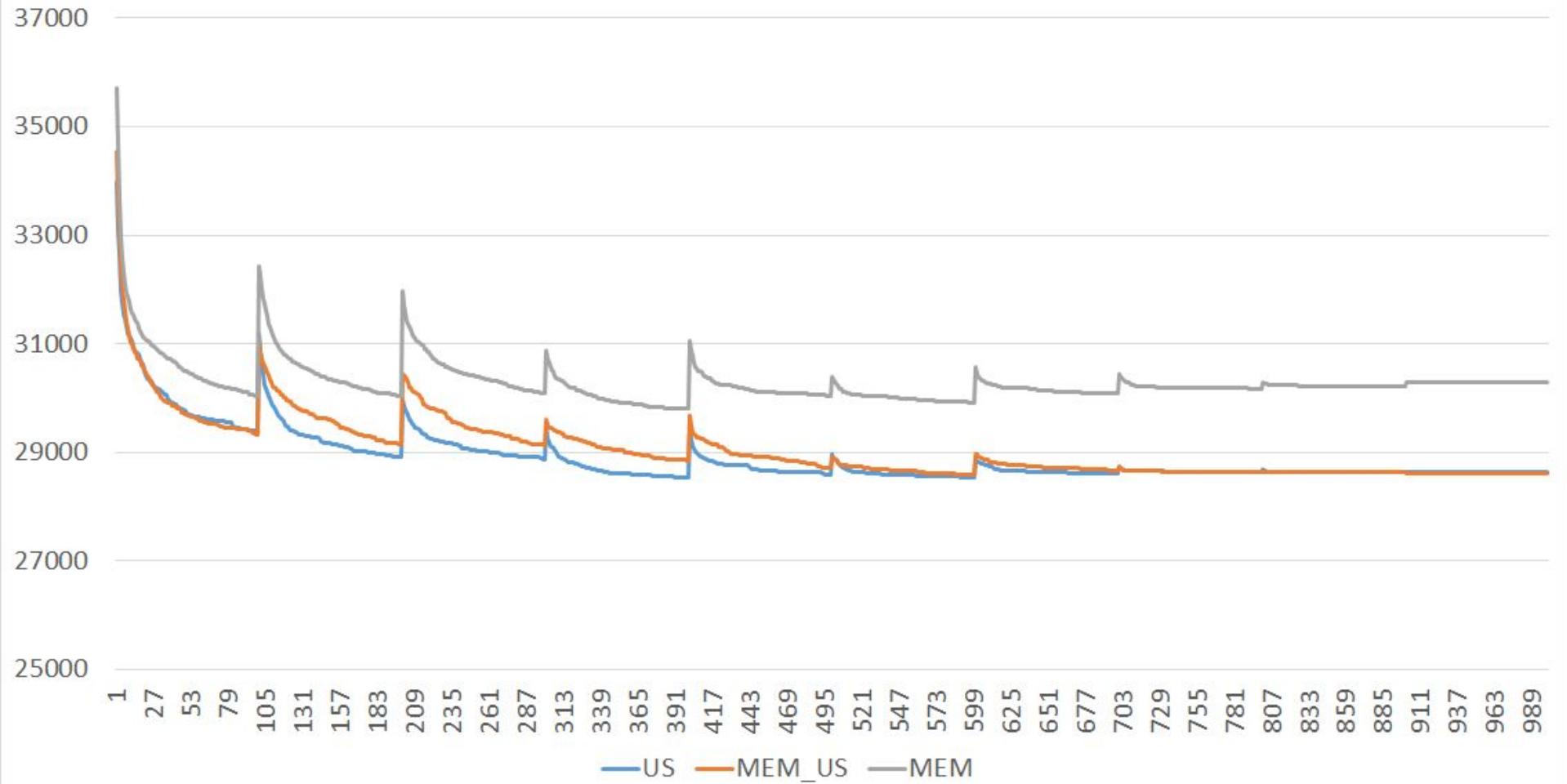
# KroA100 - freq 100 - mag 0.5



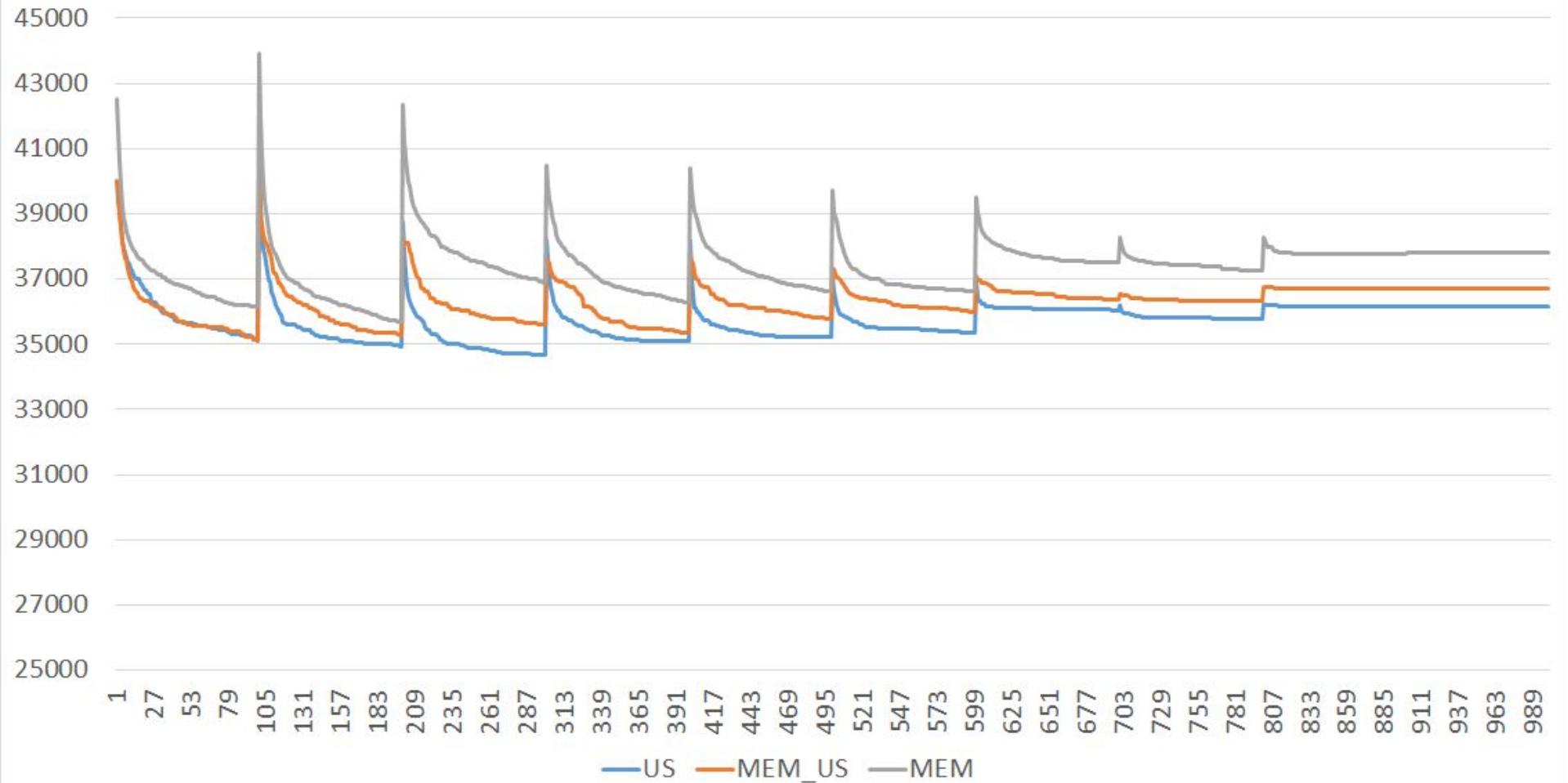
# KroA100 - freq 100 - mag 0.75



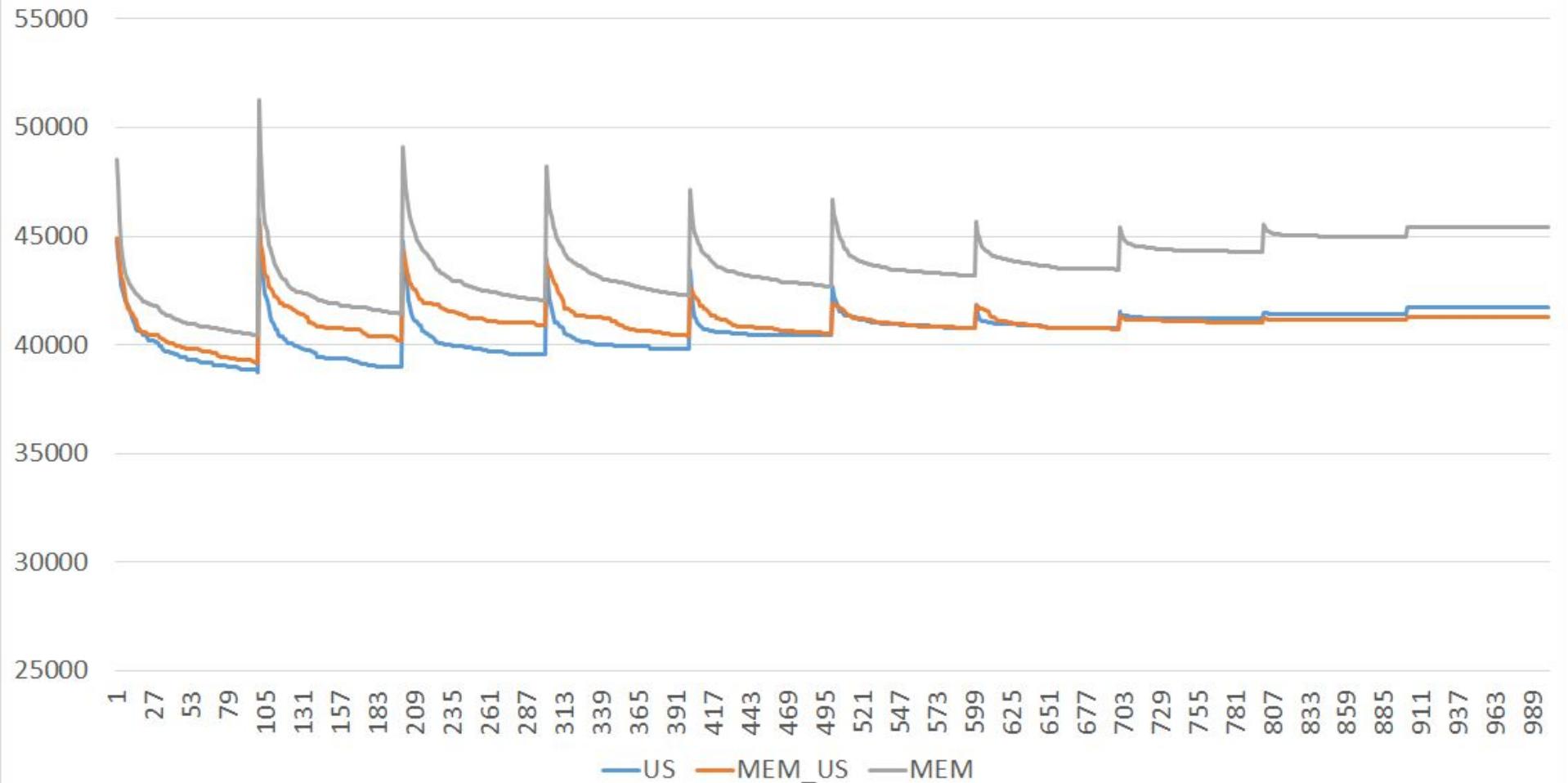
# KroA150 - freq 100 - mag 0.1



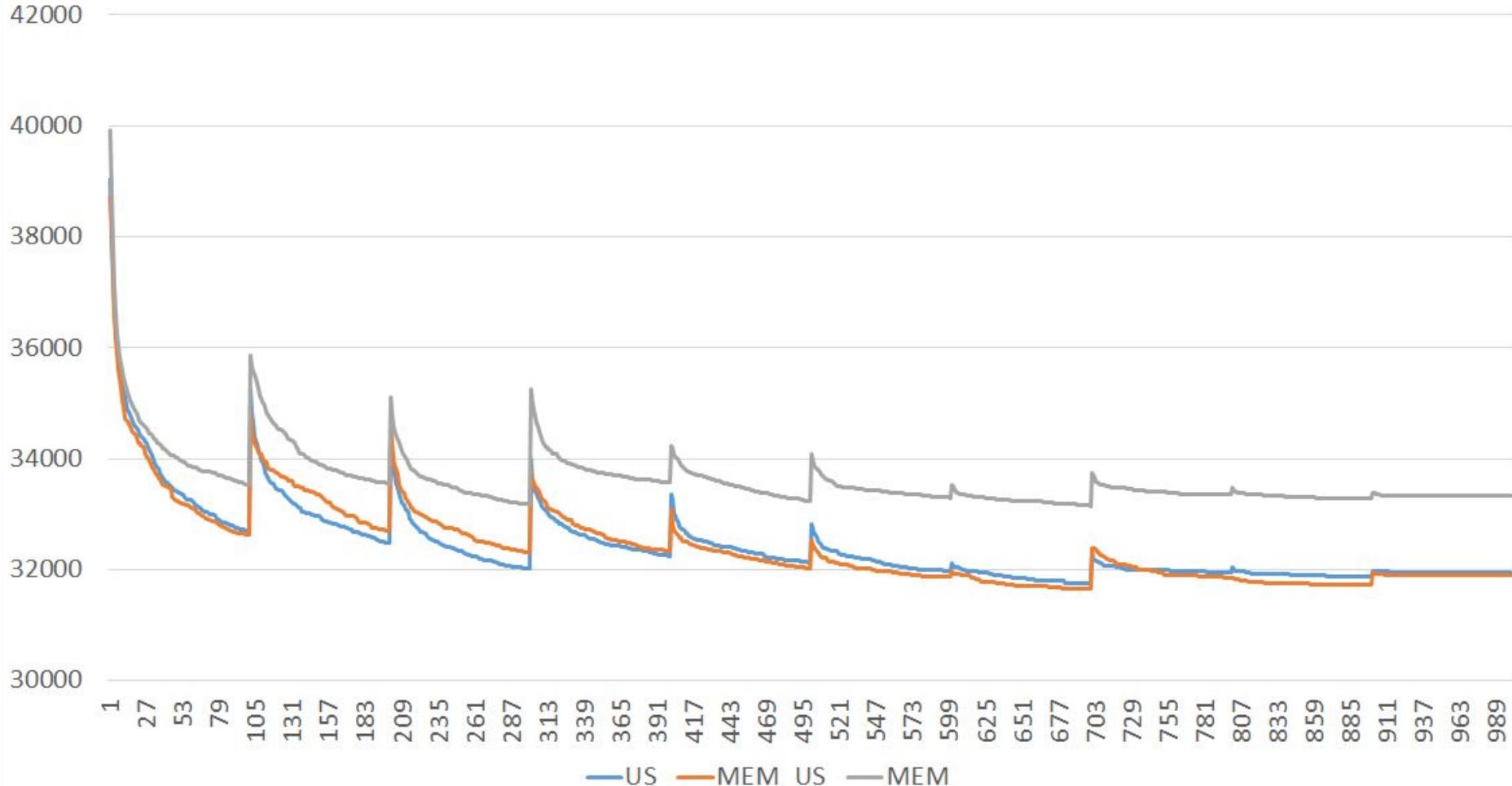
# KroA150 - freq 100 - mag 0.5



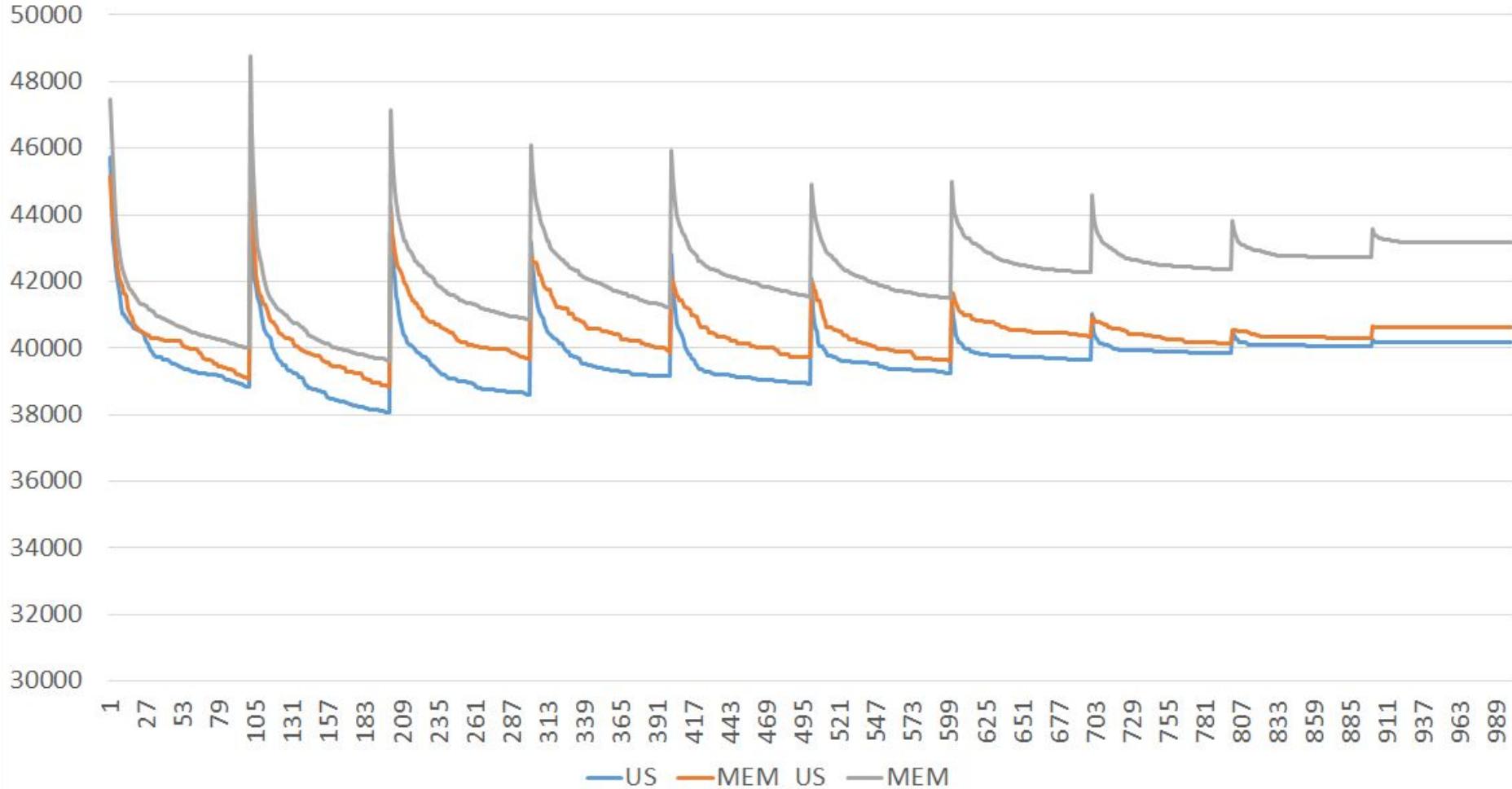
# KroA150 - freq 100 - mag 0.75



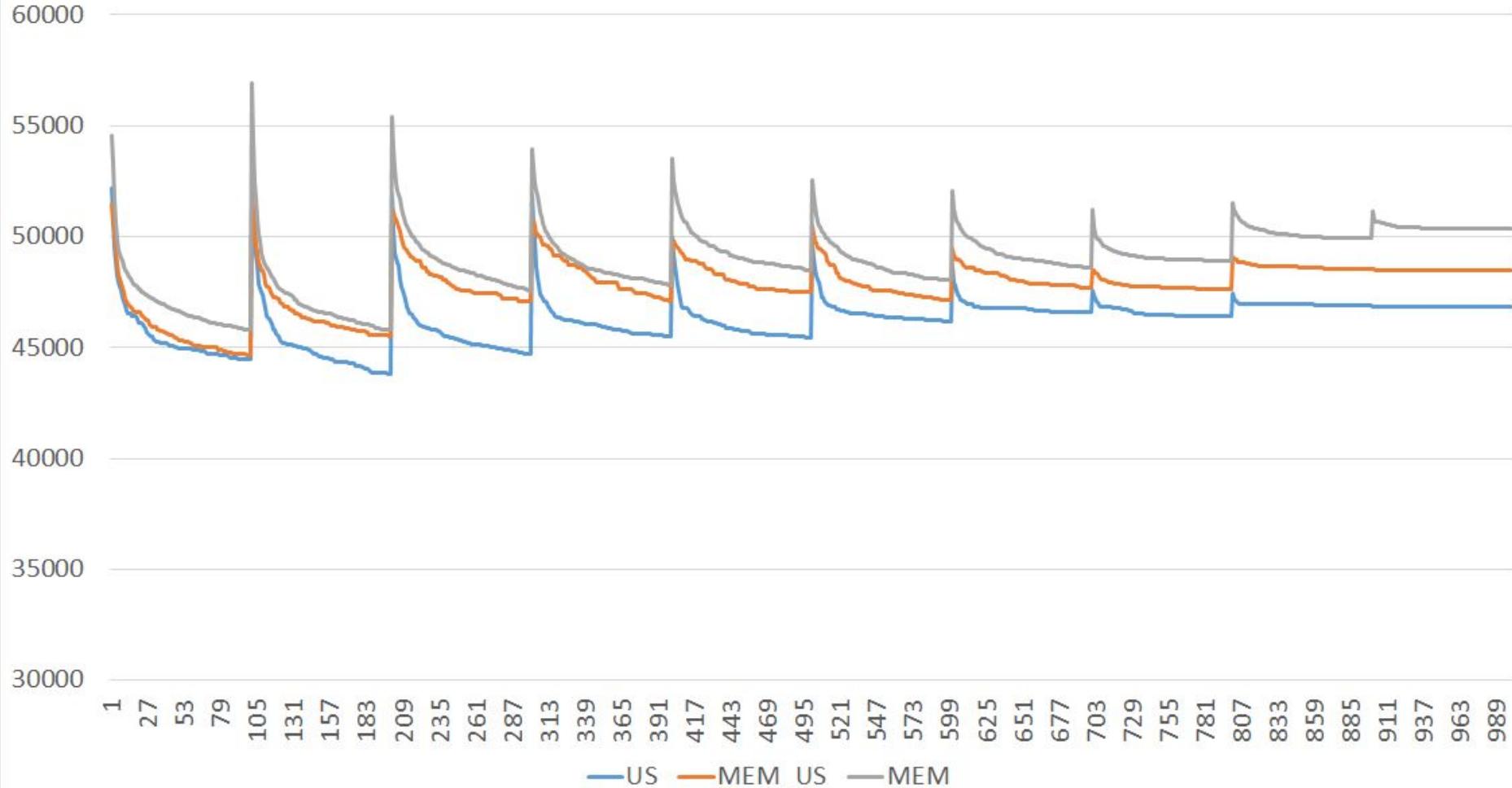
# KroA200 - freq 100 - mag 0.1



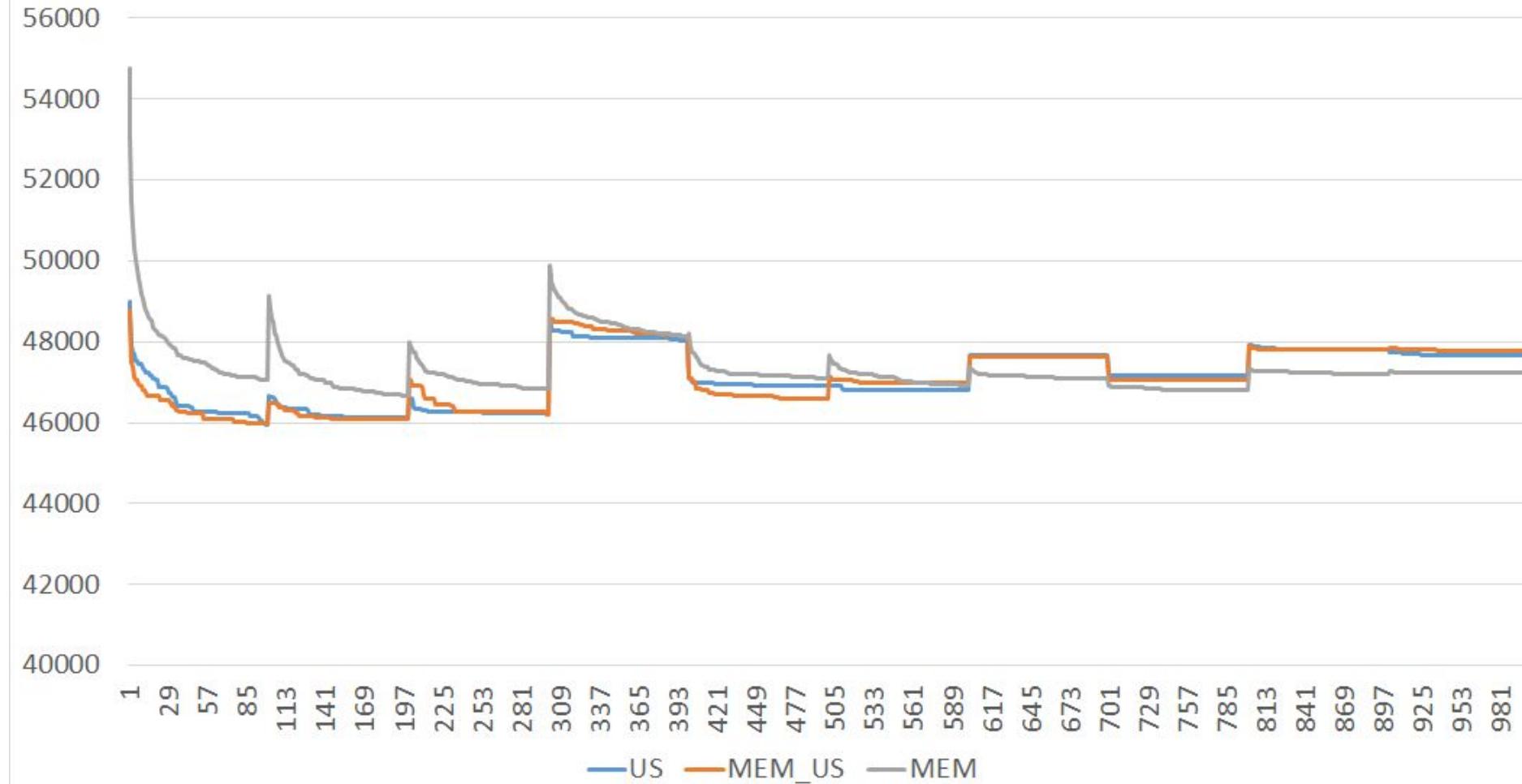
# KroA200 - freq 100 - mag 0.5



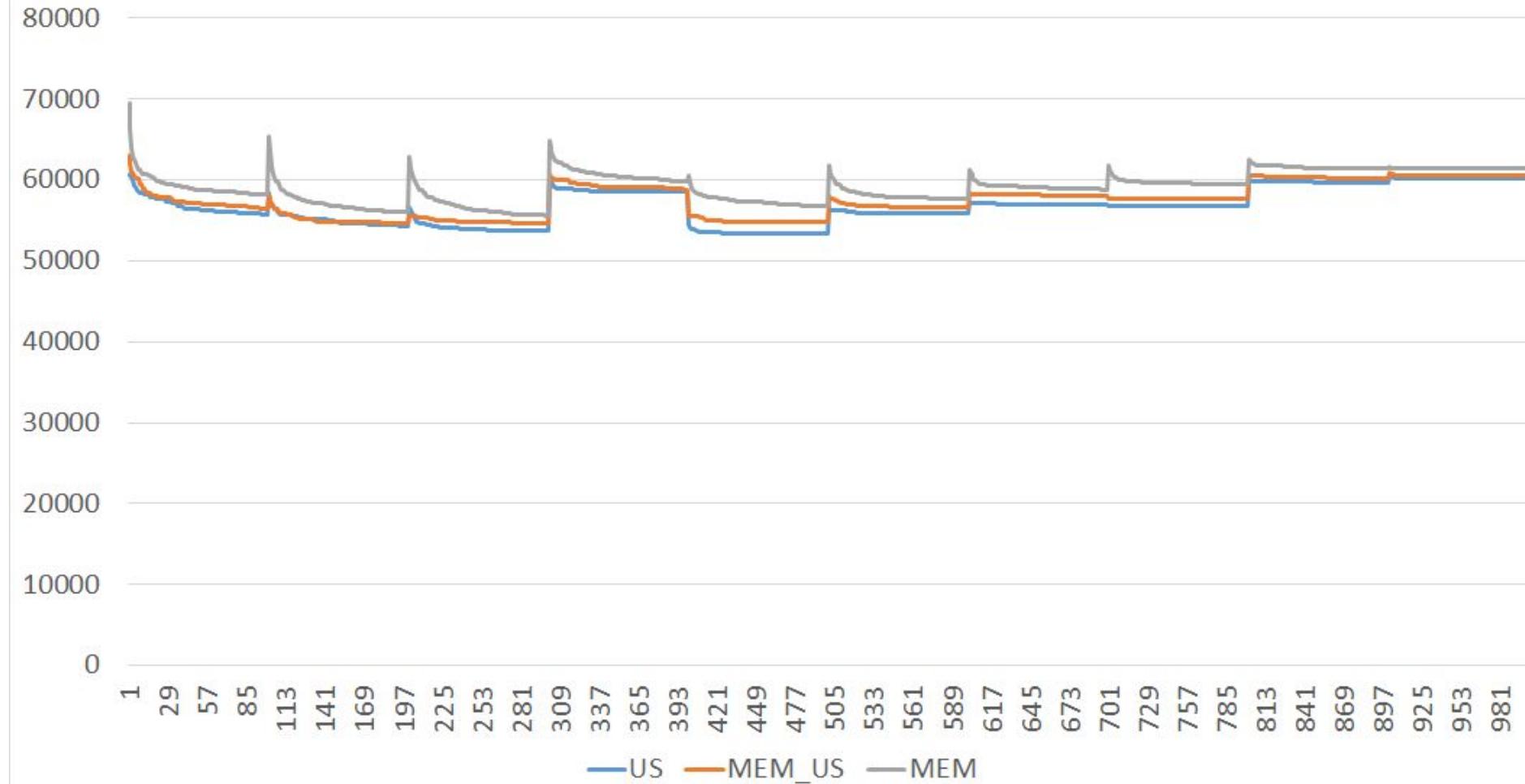
# KroA200 - freq 100 - mag 0.75



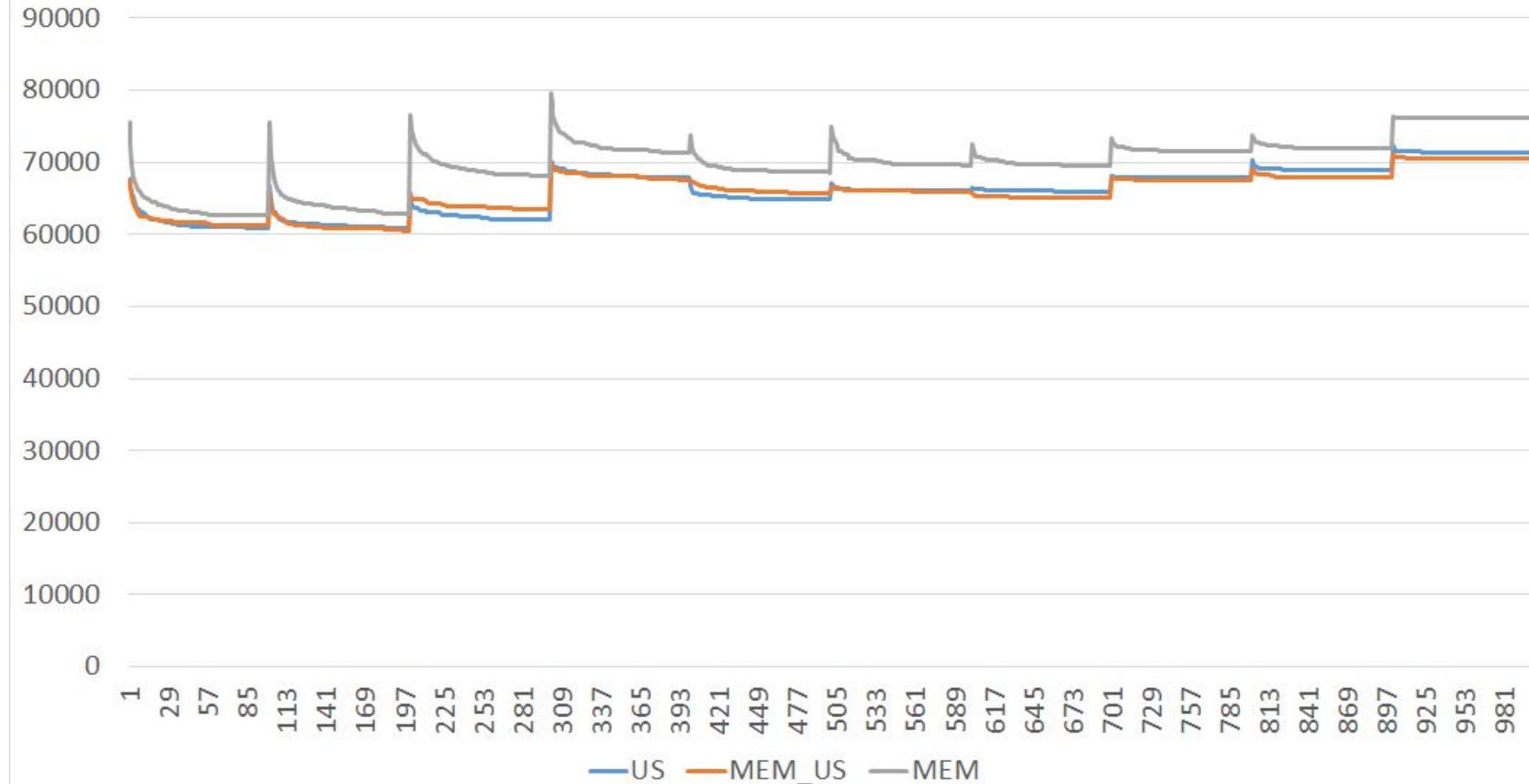
# Joinville 46 - freq 100 - mag 0.1



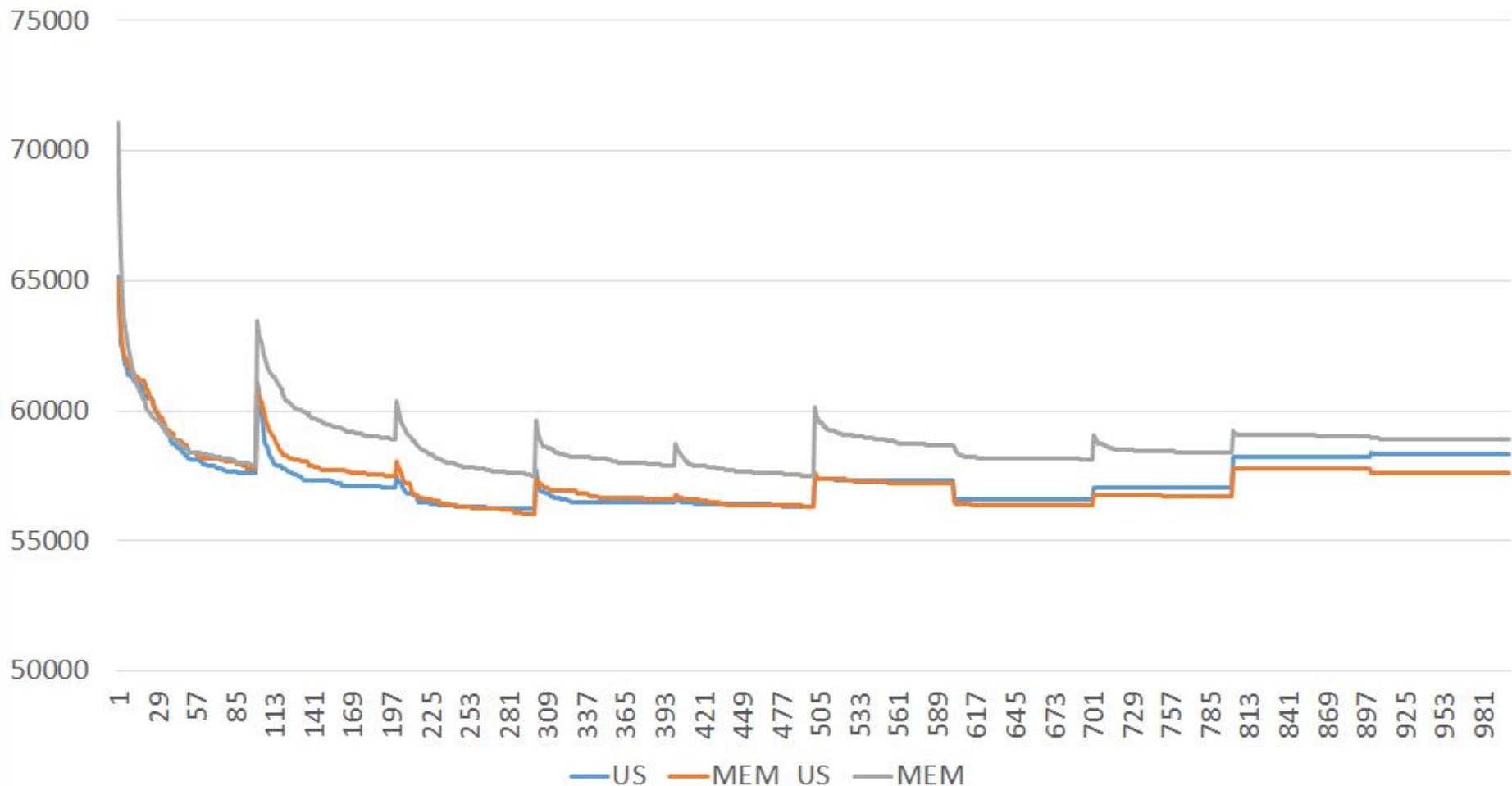
# Joinville 46 - freq 100 - mag 0.5



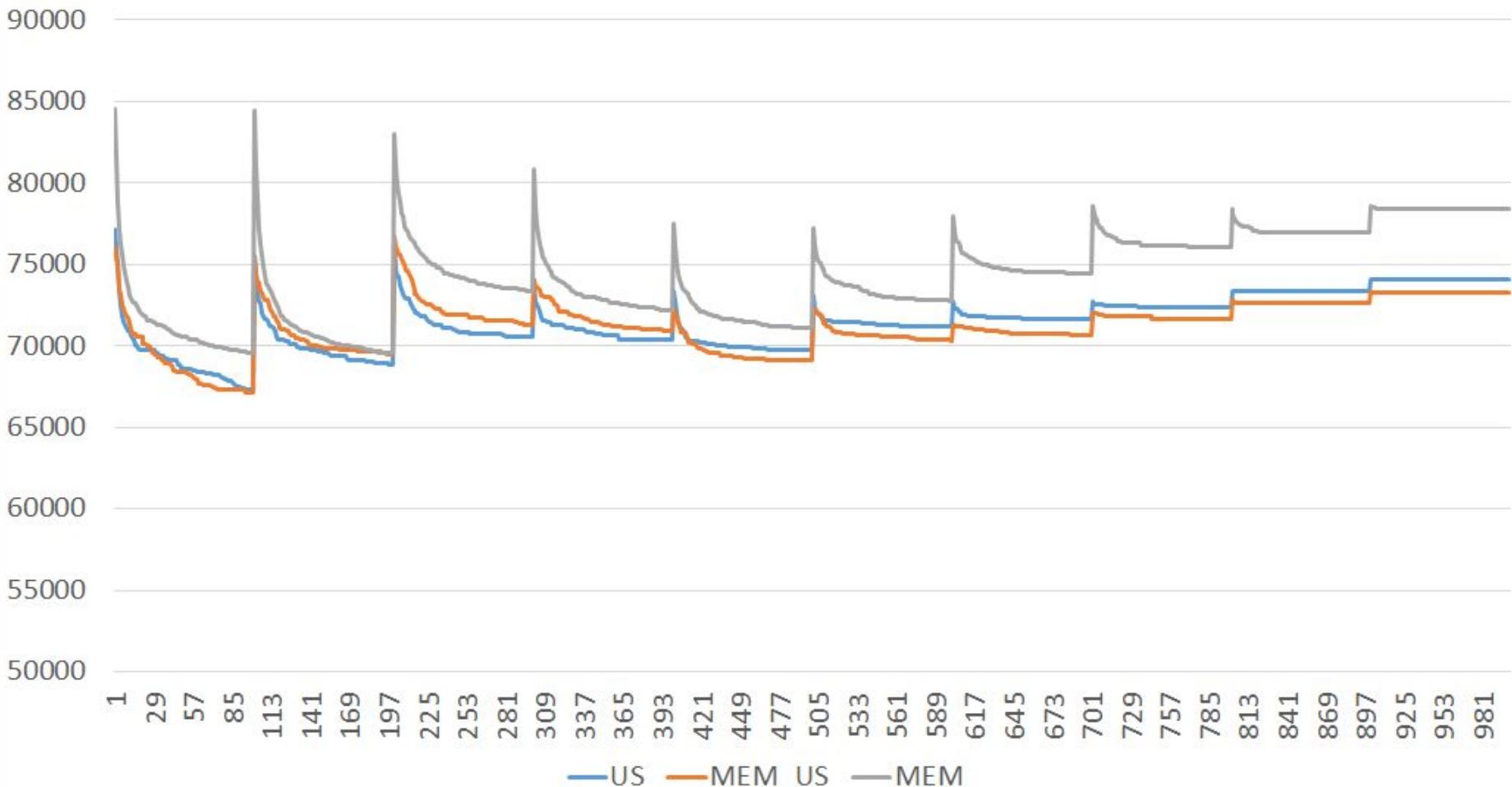
# Joinville 46 - freq 100 - mag 0.75



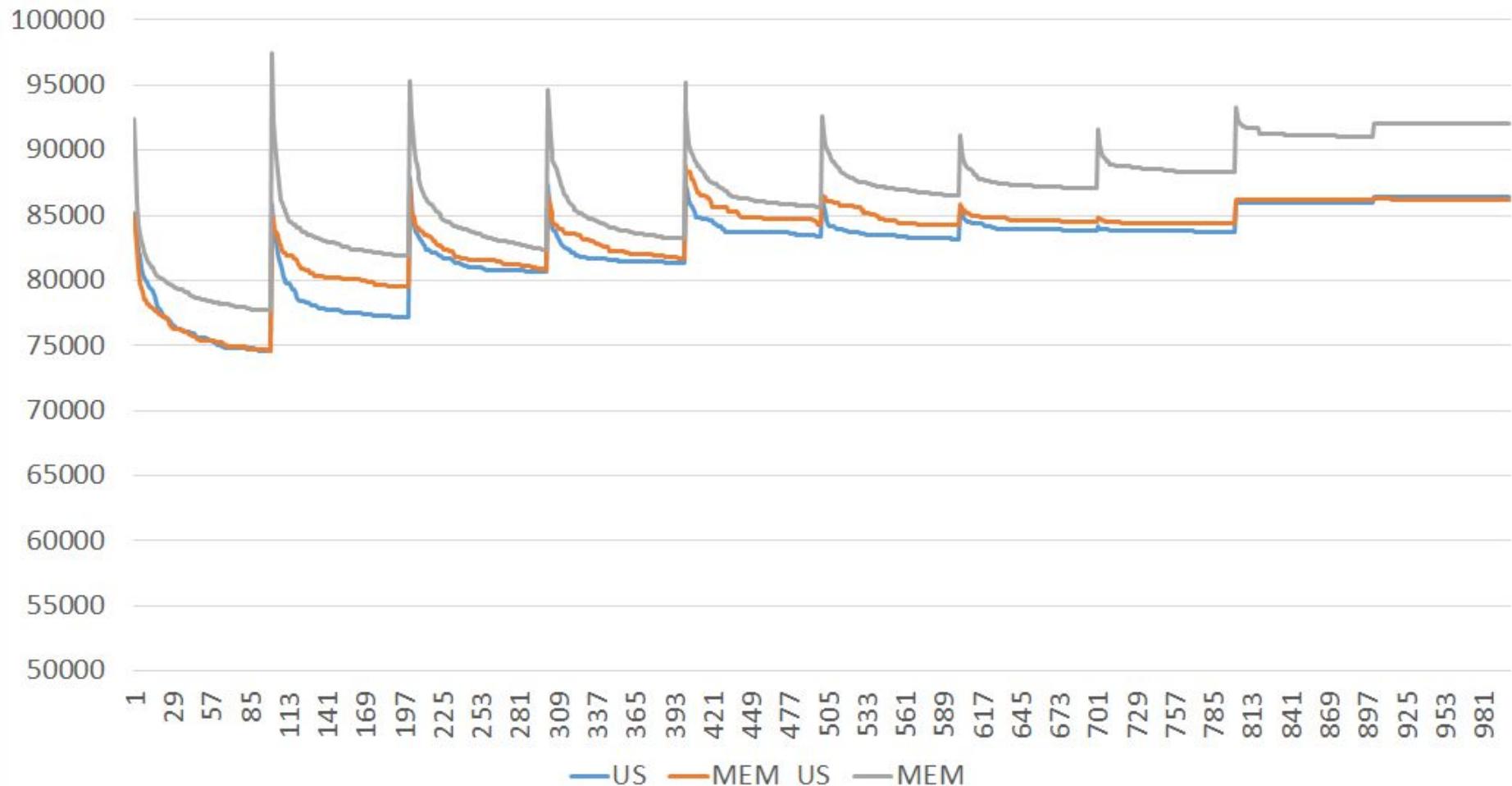
# Joinville 78 - freq 10 - mag 0.1



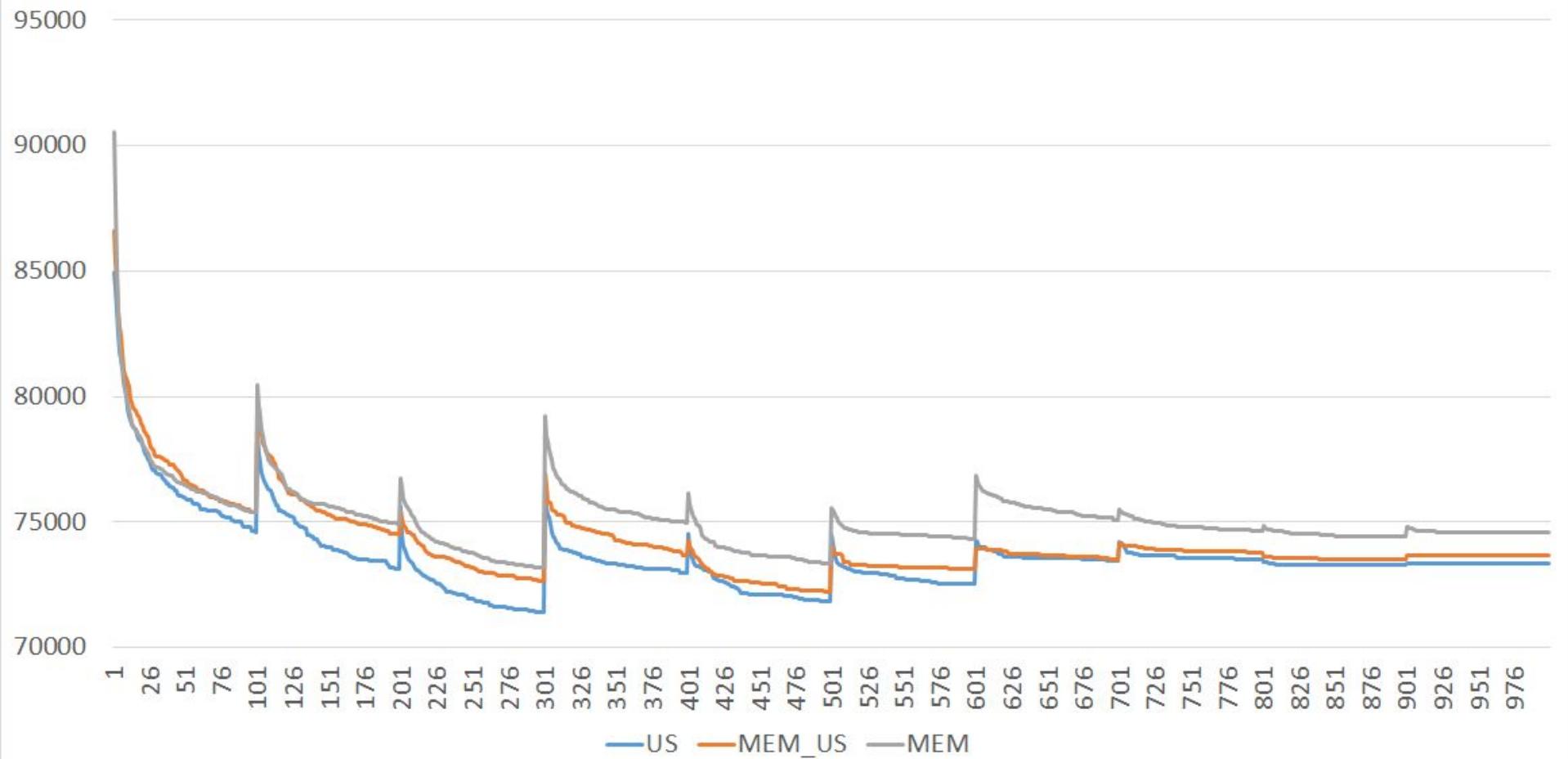
# Joinville 78 - freq 10 - mag 0.5



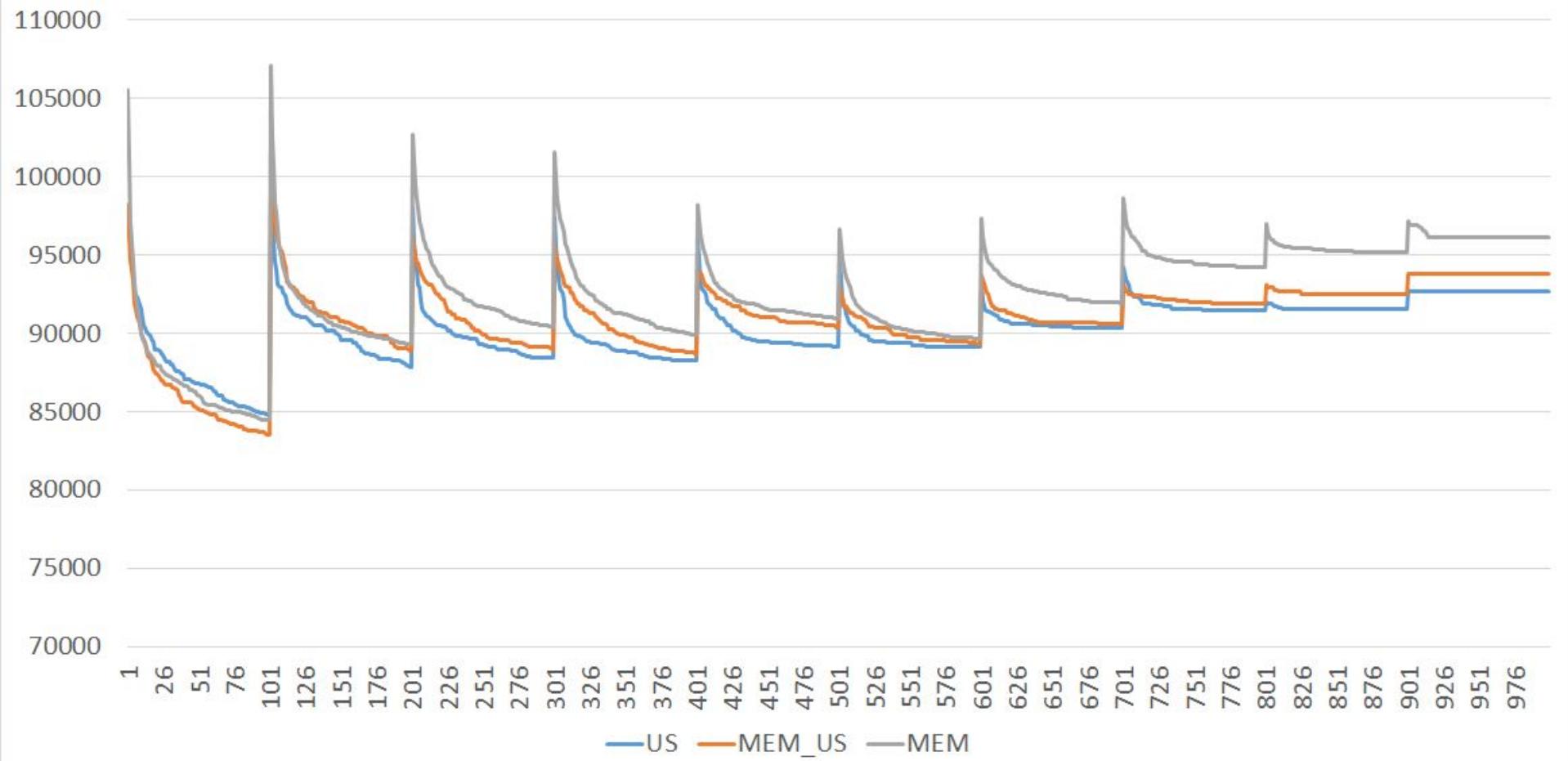
# Joinville 78 - freq 10 - mag 0.75



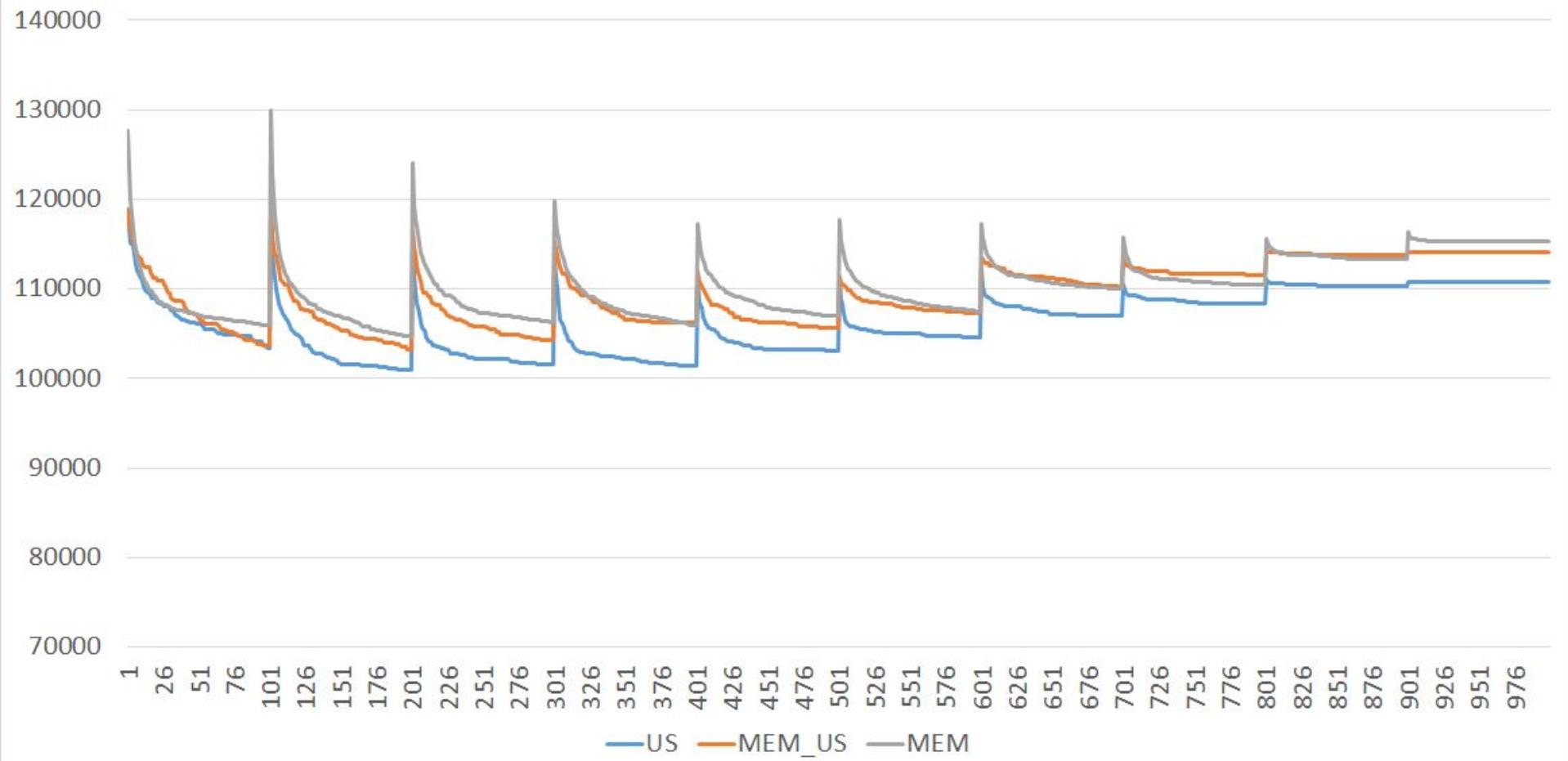
# Joinville 125 - freq 10 - mag 0.1



# Joinville 125 - freq 10 - mag 0.5



### Joinville 125 - freq 10 - mag 0.75

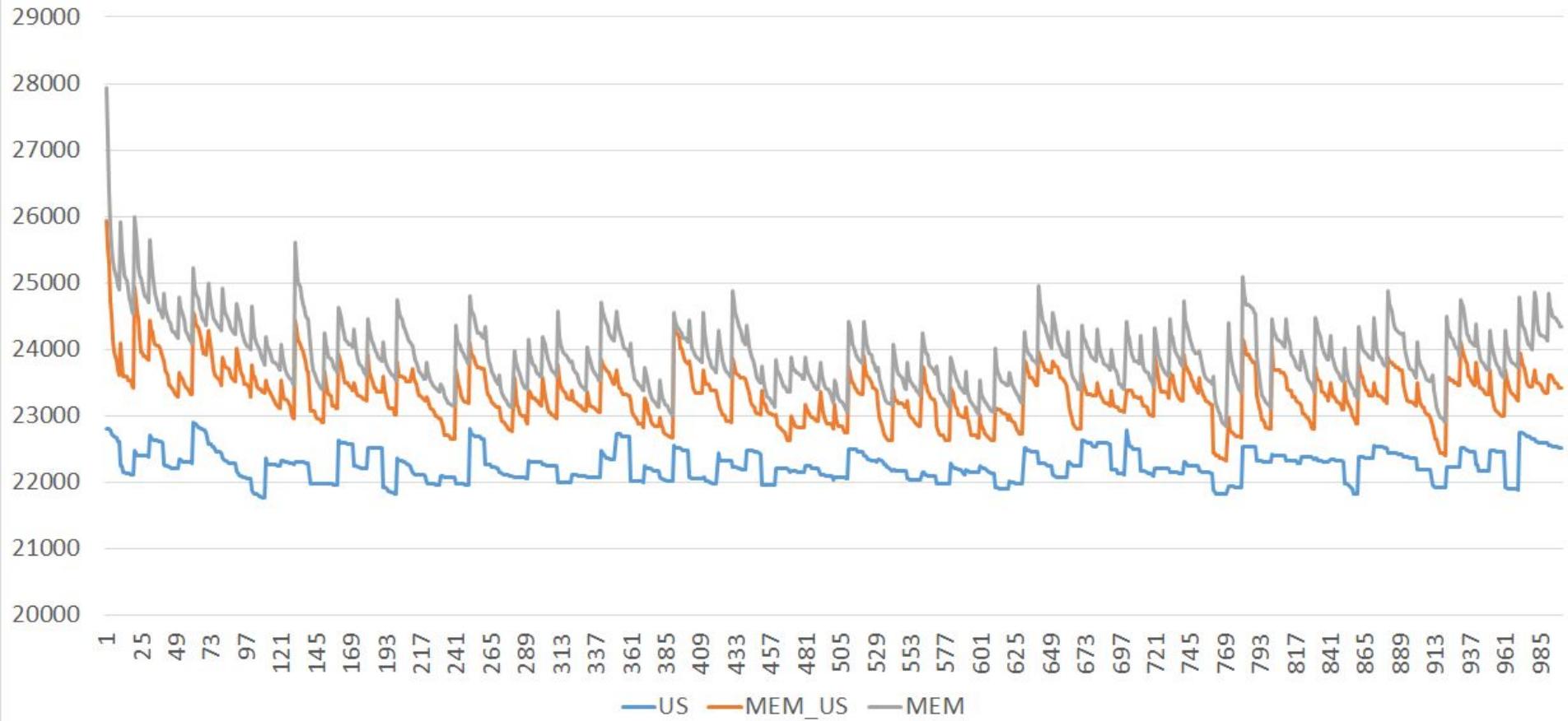


# MMAS<sub>MEM</sub> vs MMAS<sub>US</sub> vs MMAS<sub>MEM\_US</sub> para Stationary ADTSP

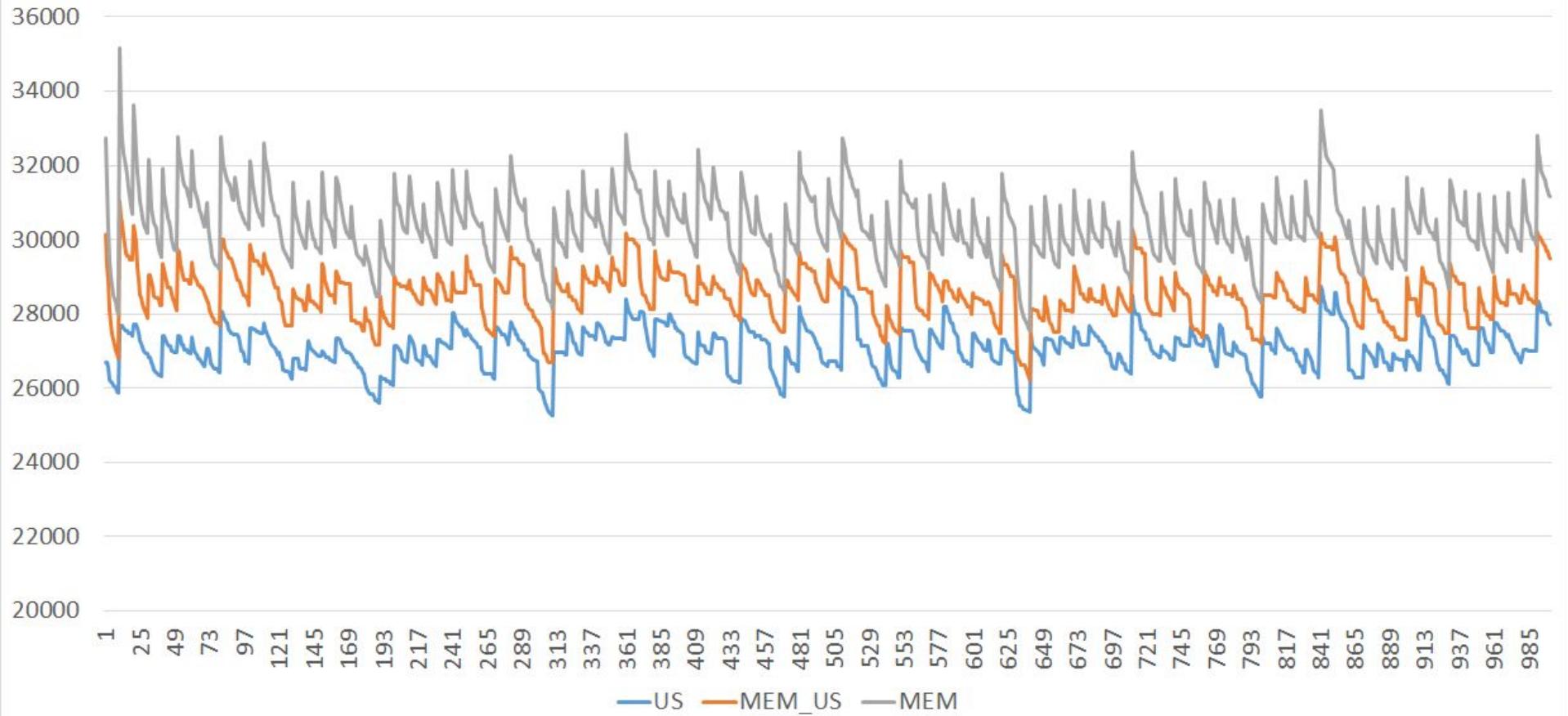
João Pedro Schmitt

Frequência = 10

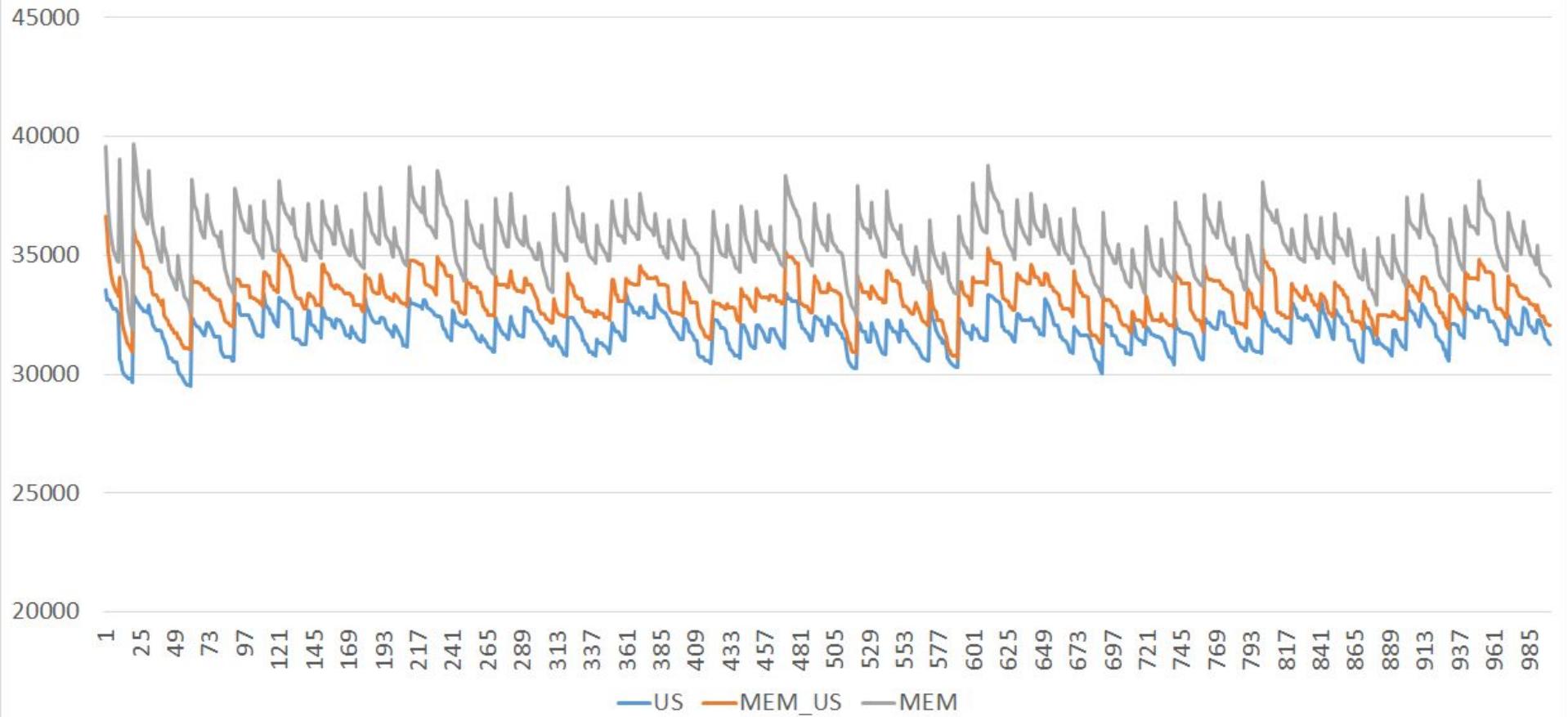
### KroA100 - freq 10 - mag 0.1



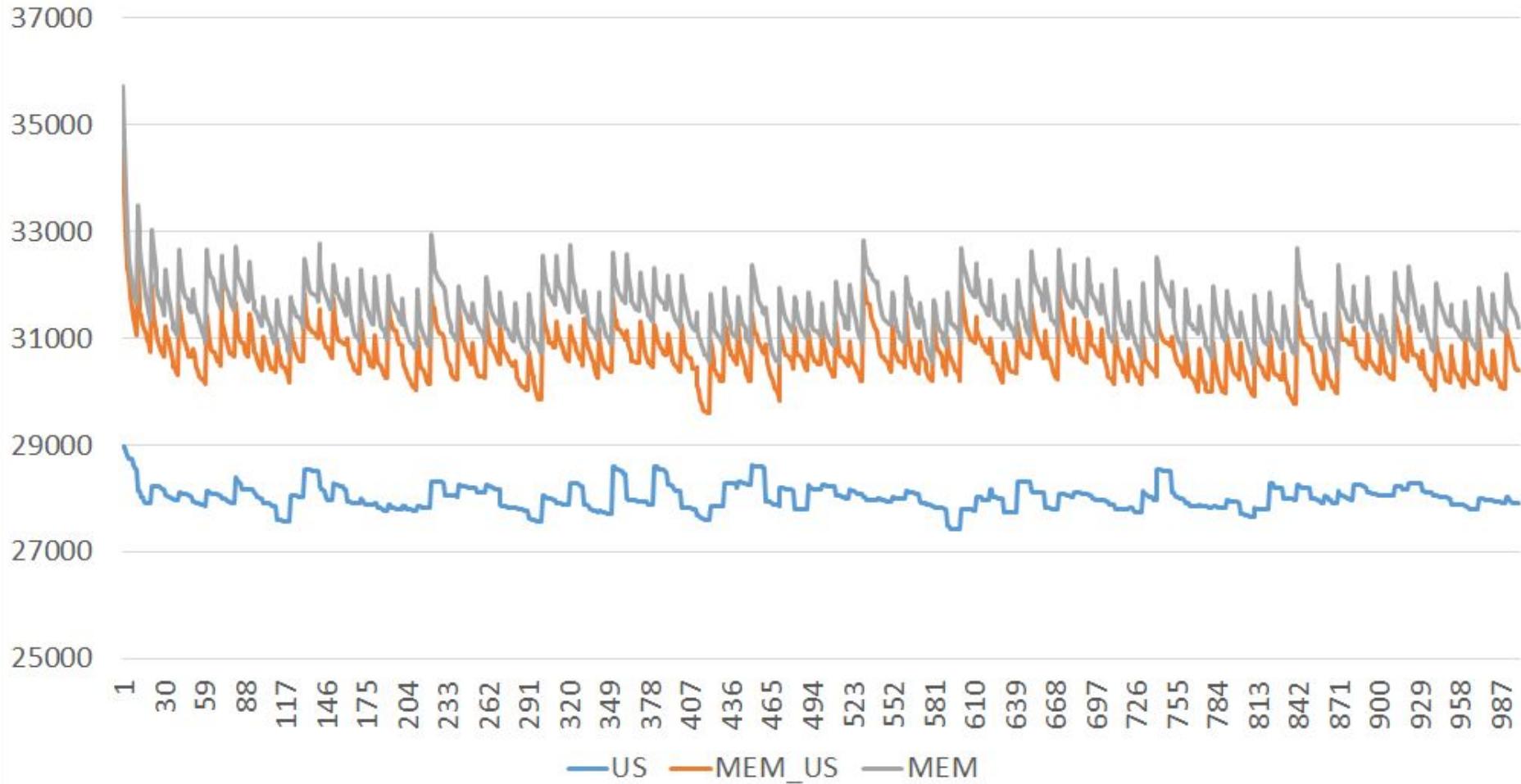
### KroA100 - freq 10 - mag 0.5



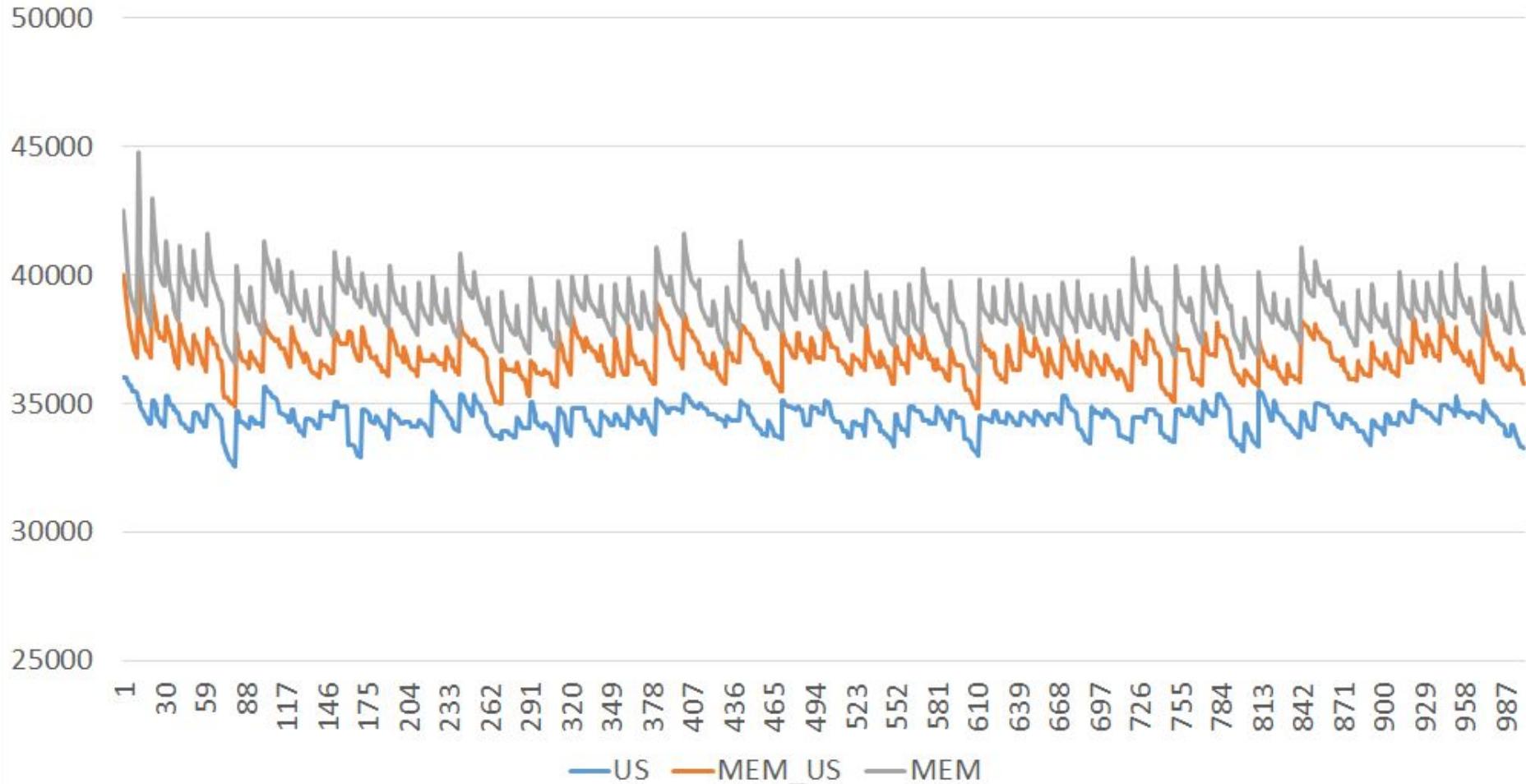
### KroA100 - freq 10 - mag 0.75



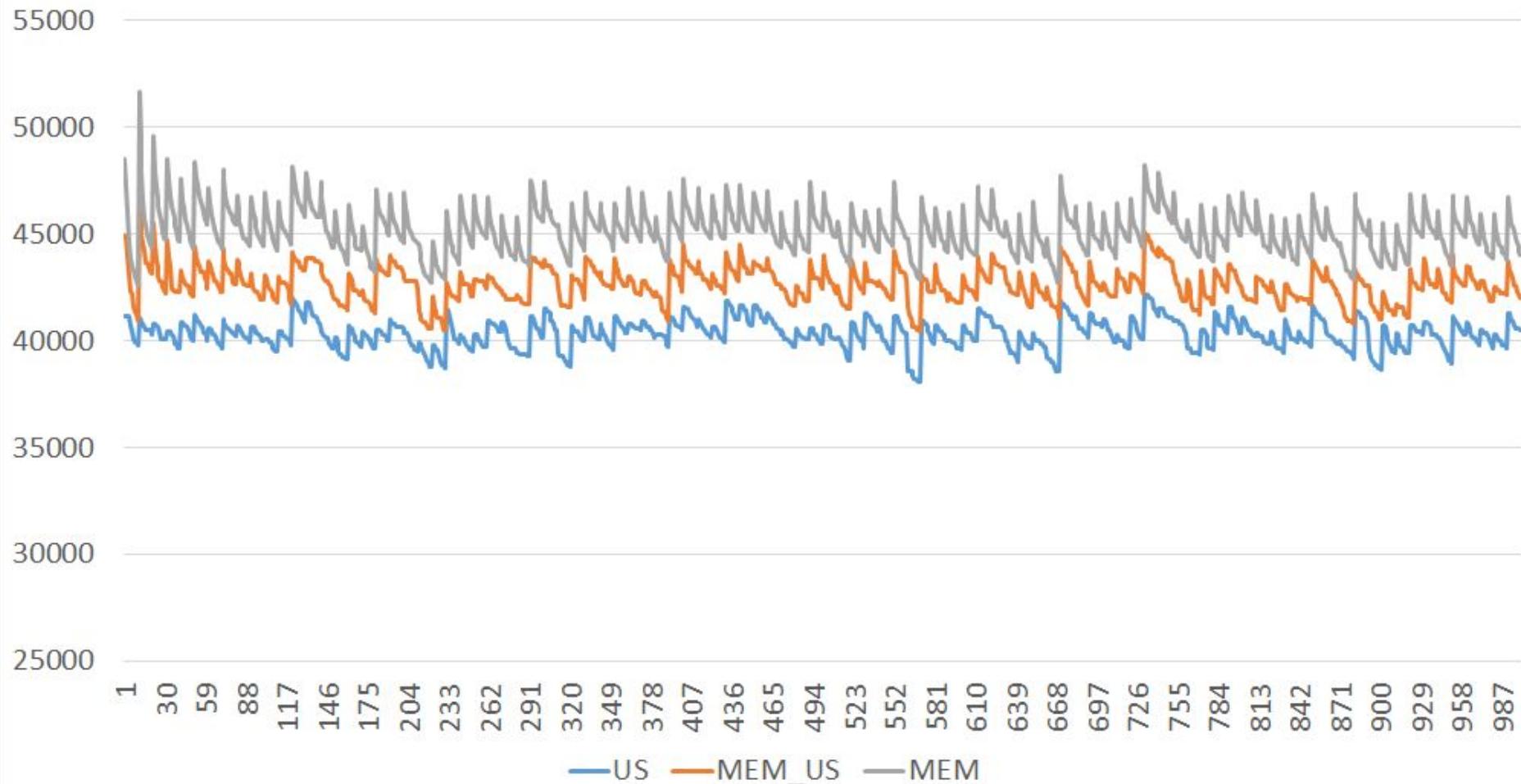
# KroA150 - freq 10 - mag 0.1



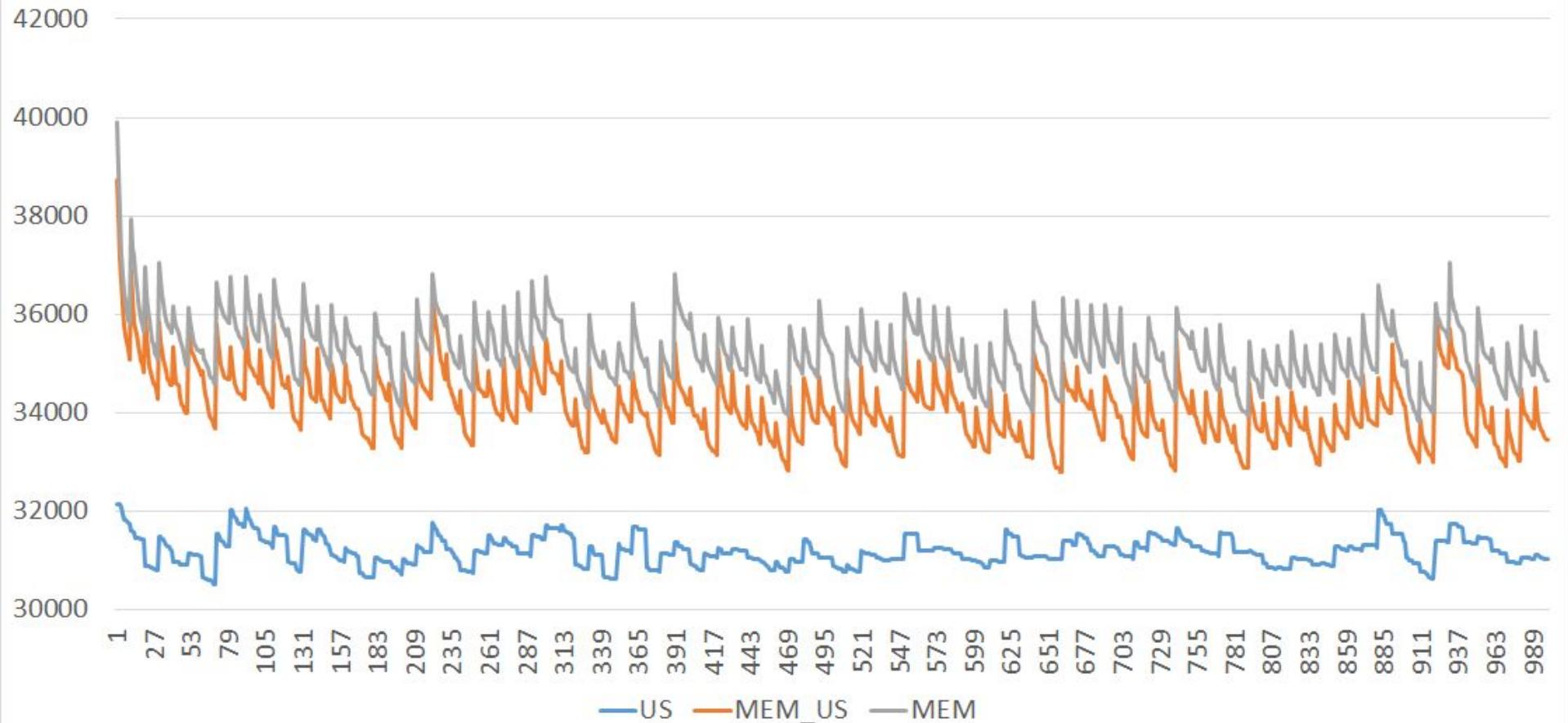
# KroA150 - freq 10 - mag 0.5



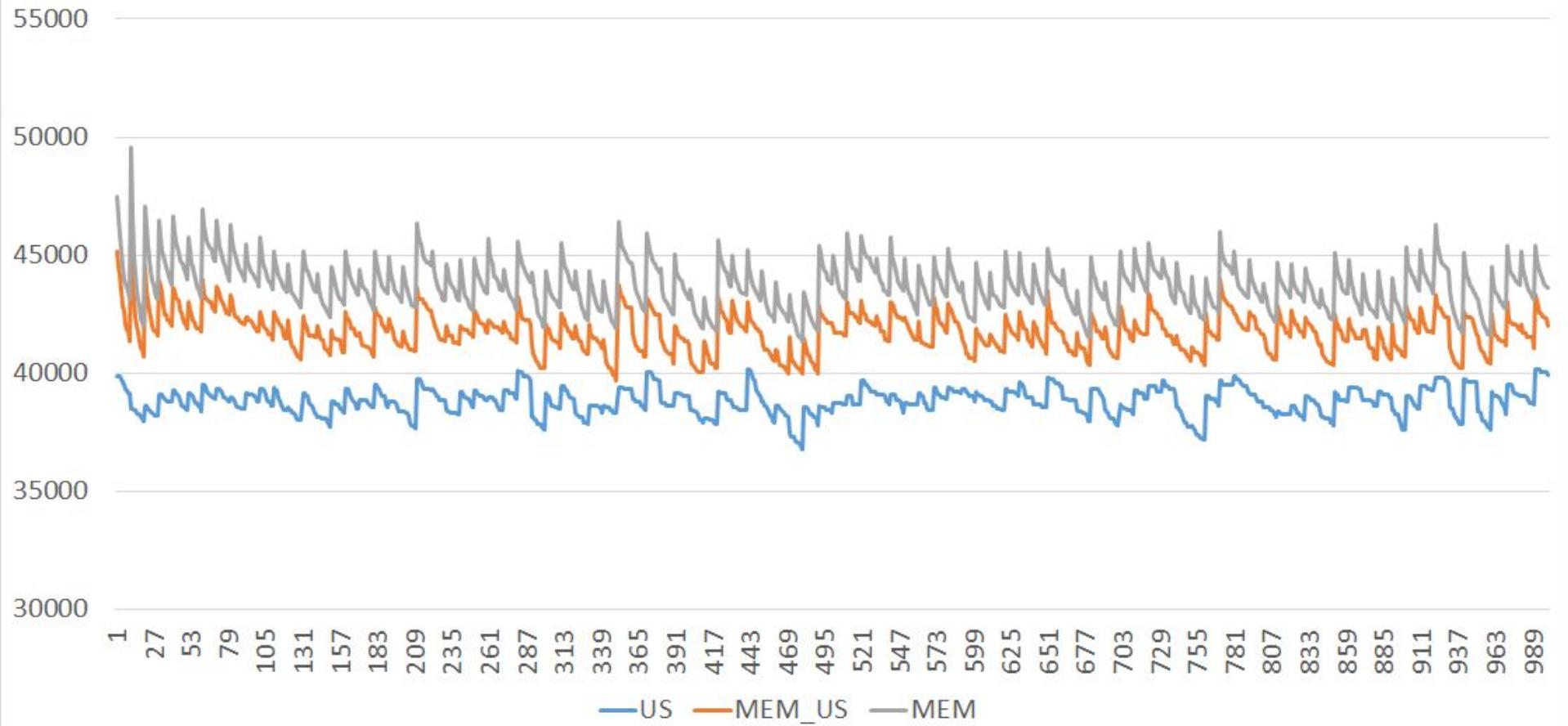
# KroA150 - freq 10 - mag 0.75



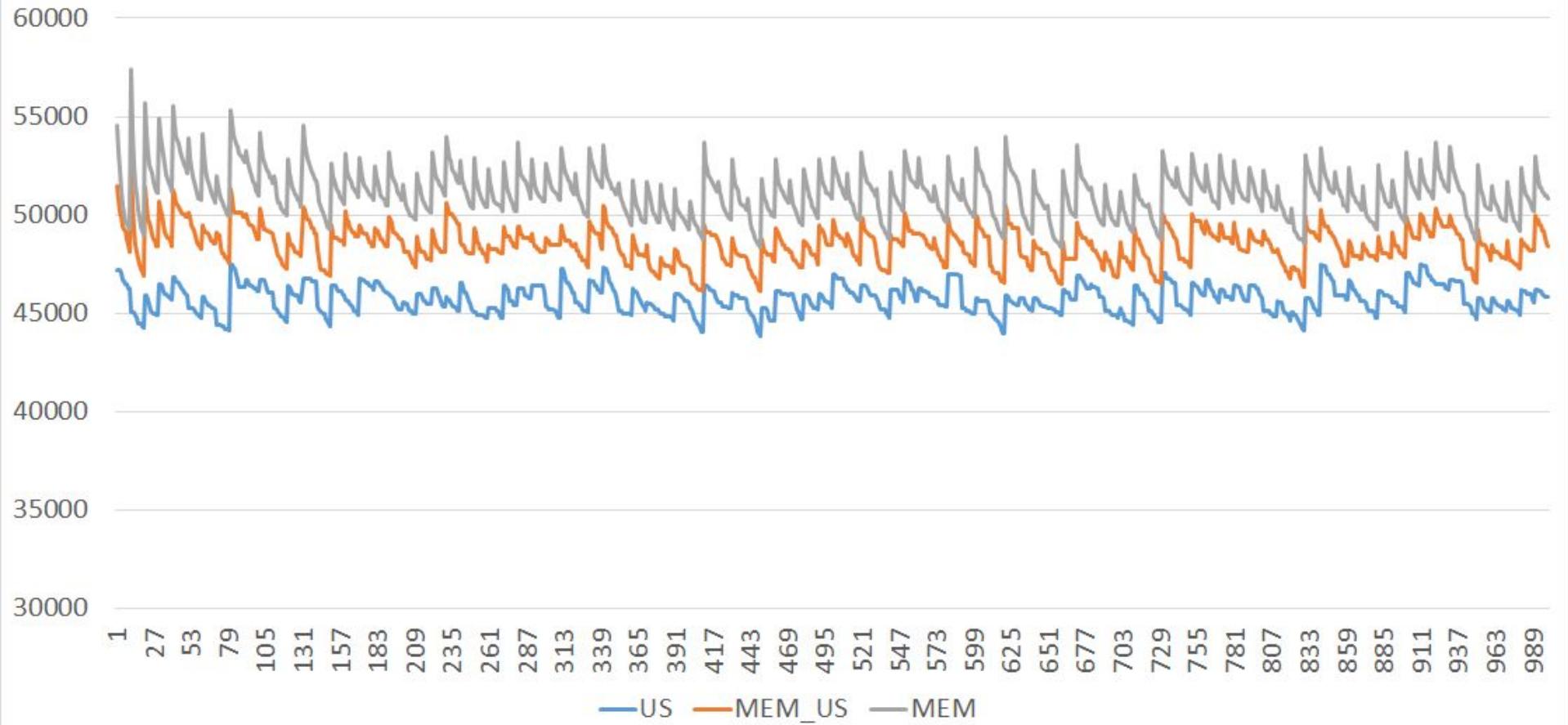
### KroA200 - freq 10 - mag 0.1



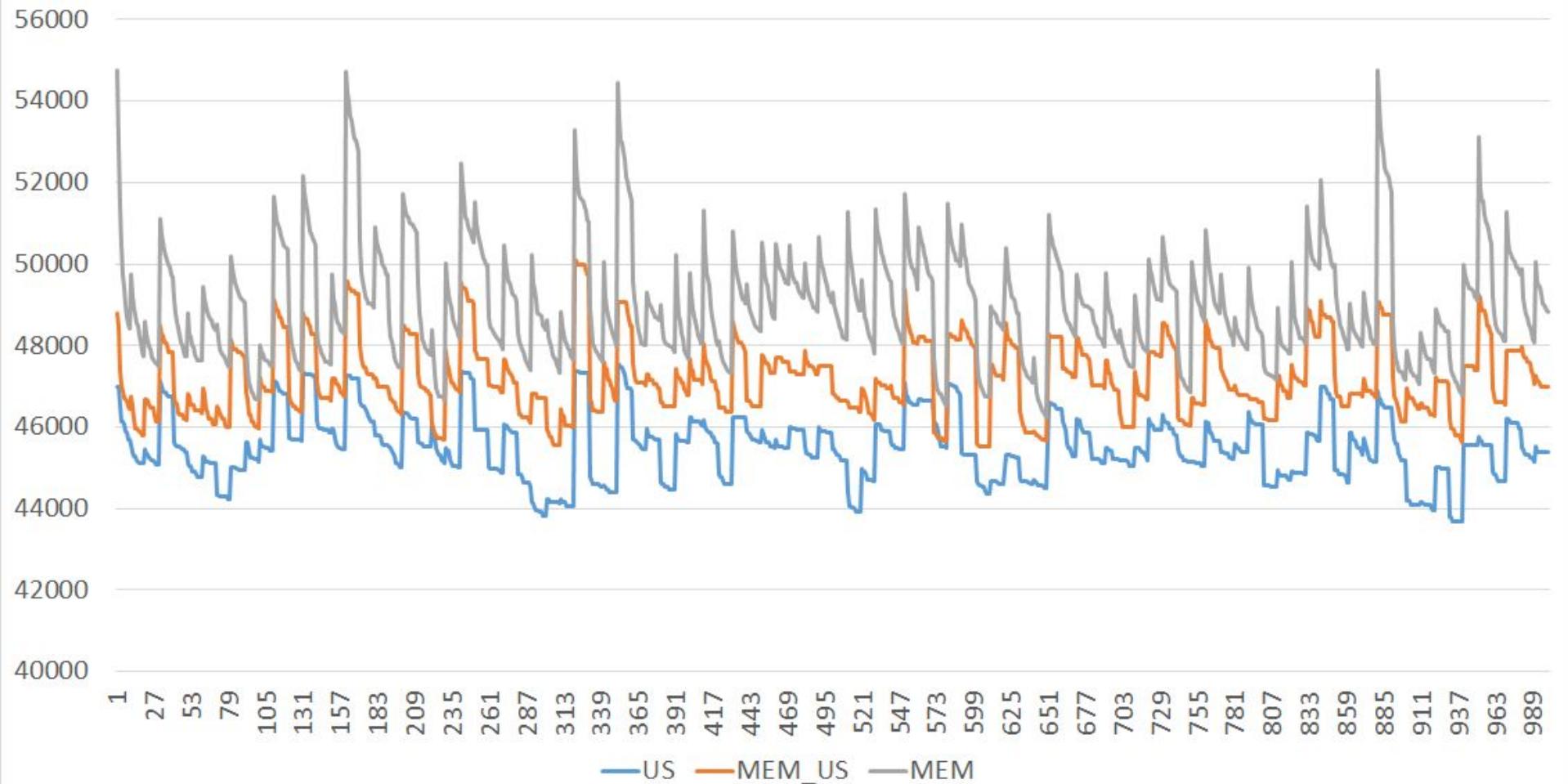
### KroA200 - freq 10 - mag 0.5



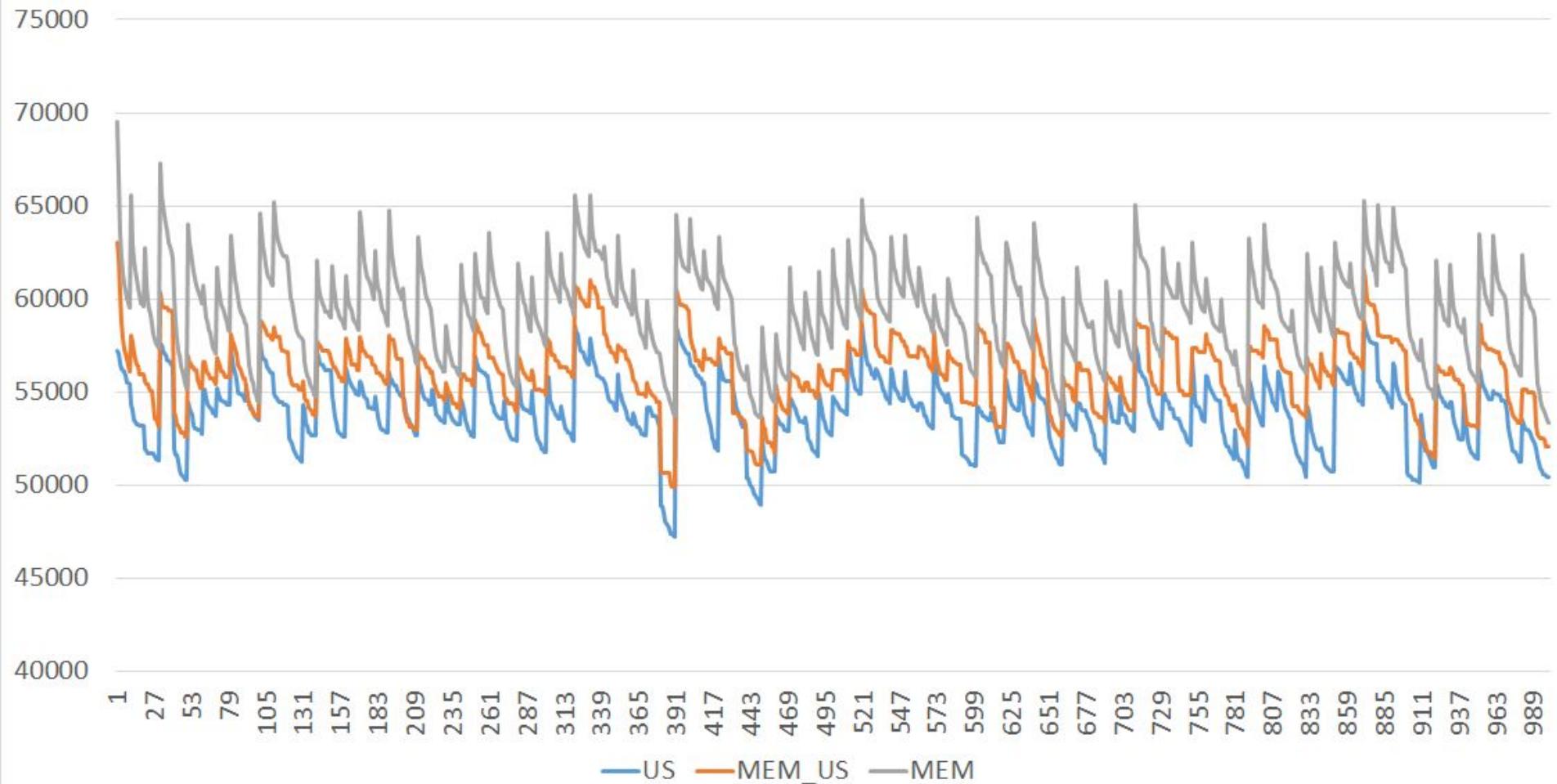
### KroA200 - freq 10 - mag 0.75



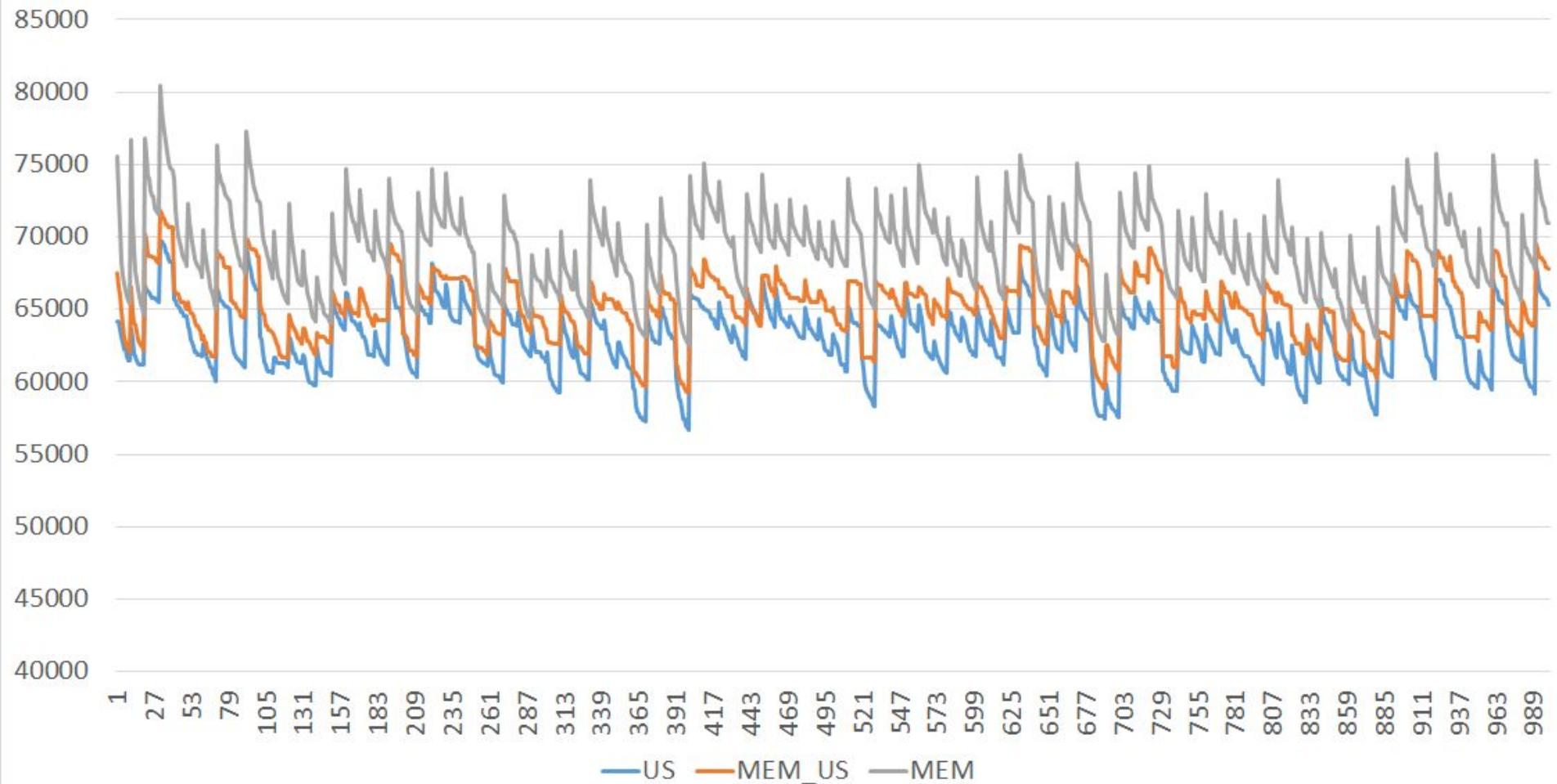
# Joinville 46 - freq 10 - mag 0.1



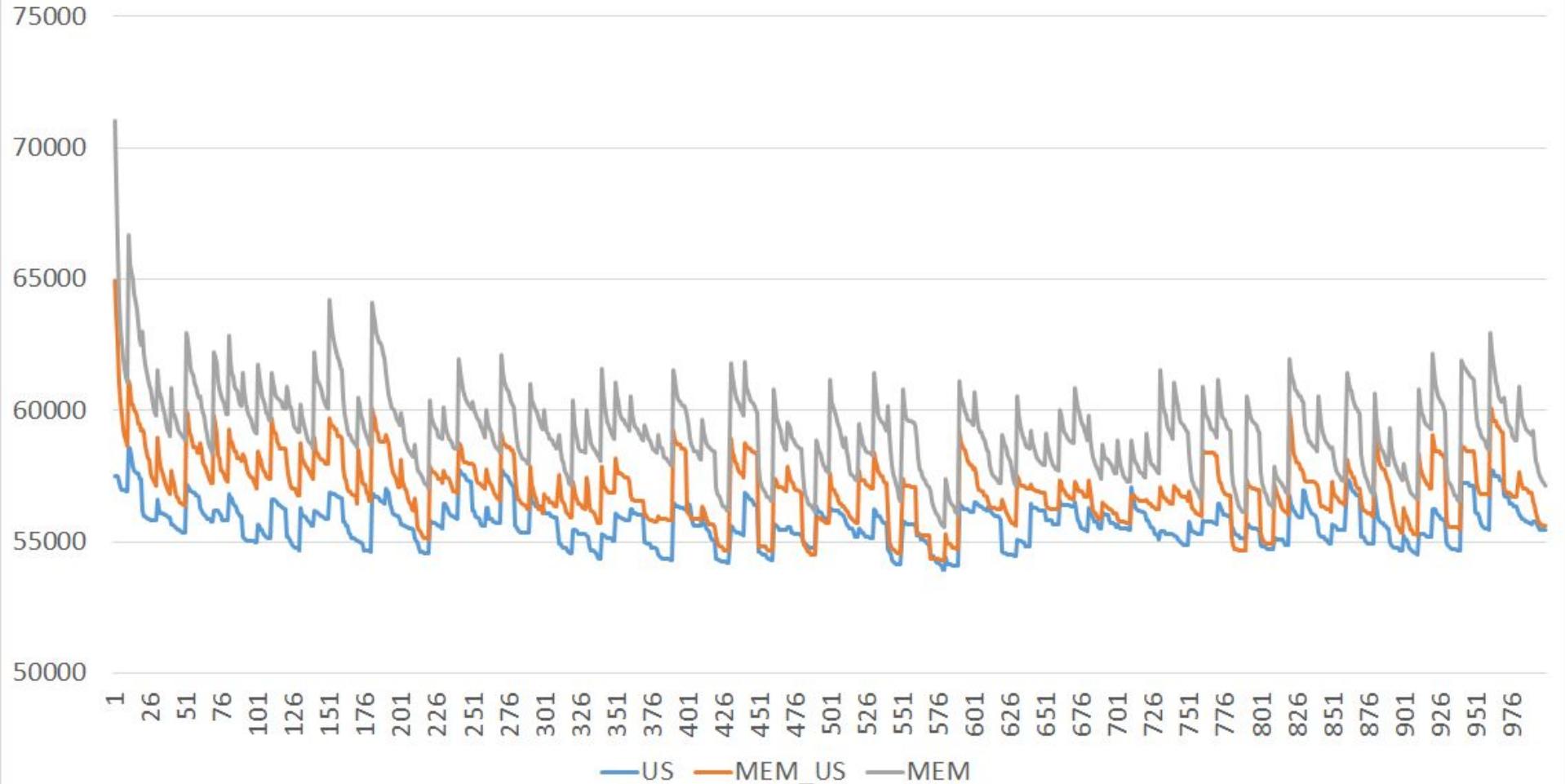
# Joinville 46 - freq 10 - mag 0.5



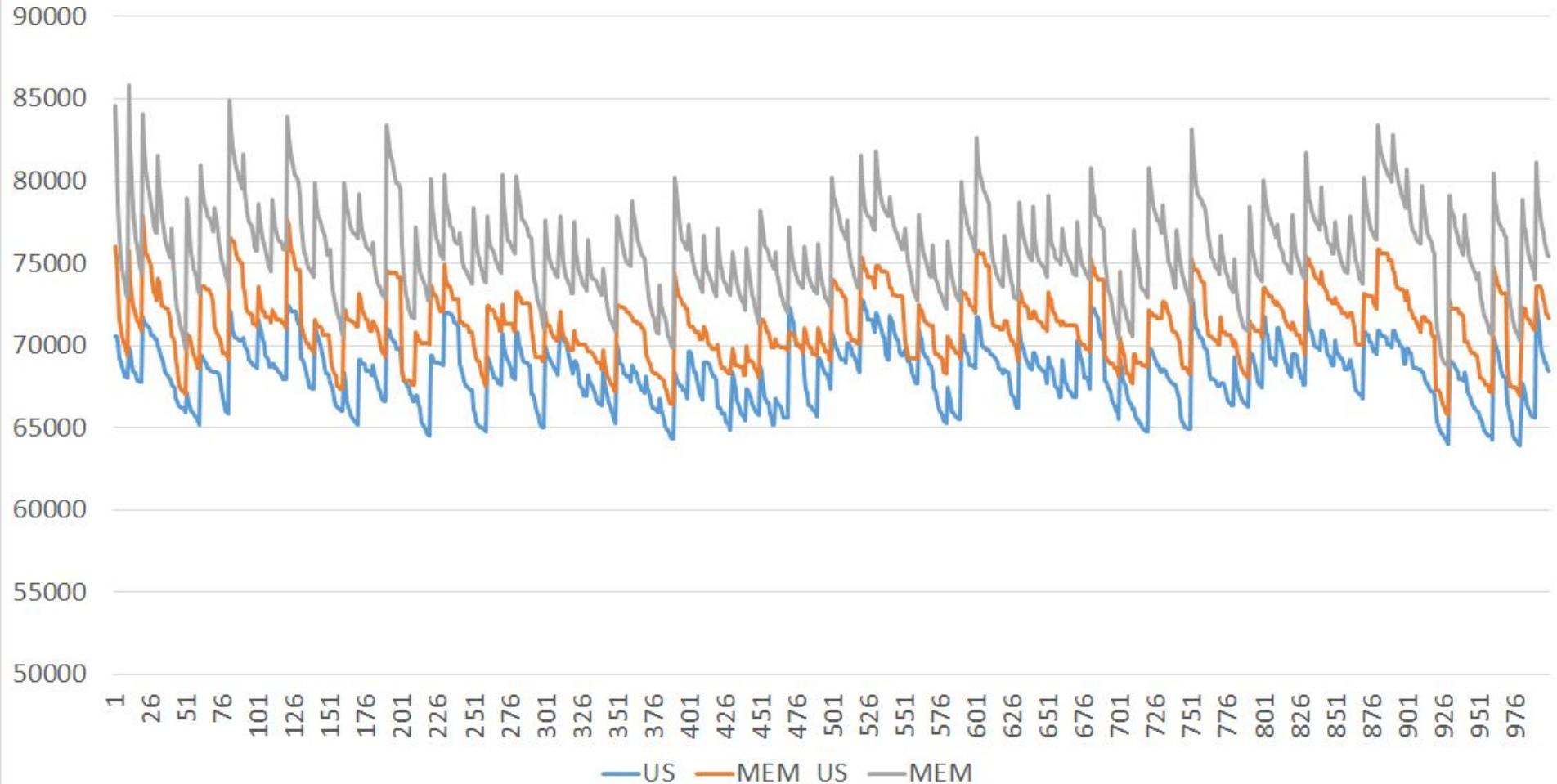
# Joinville 46 - freq 10 - mag 0.75



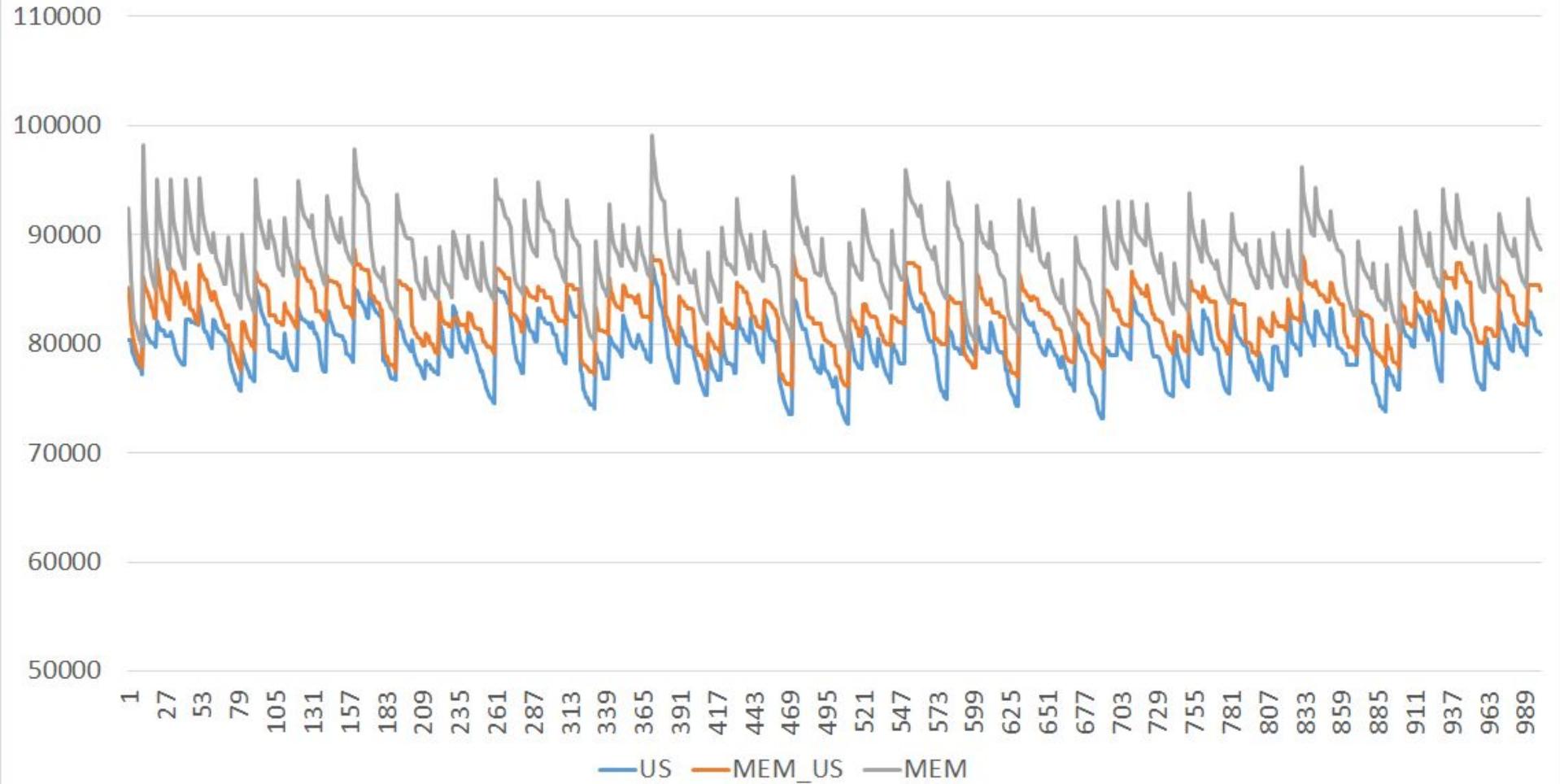
# Joinville 78 - freq 10 - mag 0.1



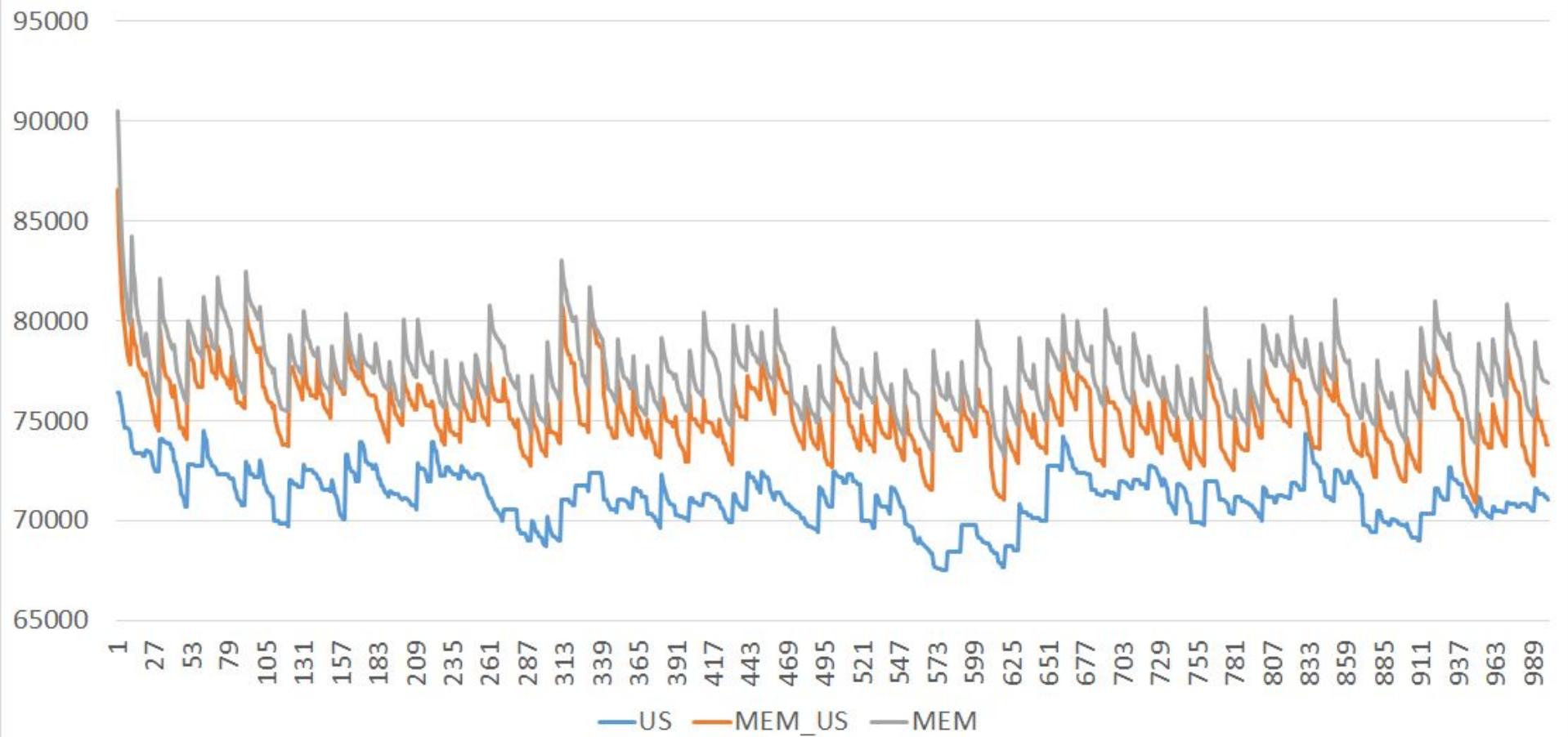
# Joinville 78 - freq 10 - mag 0.5



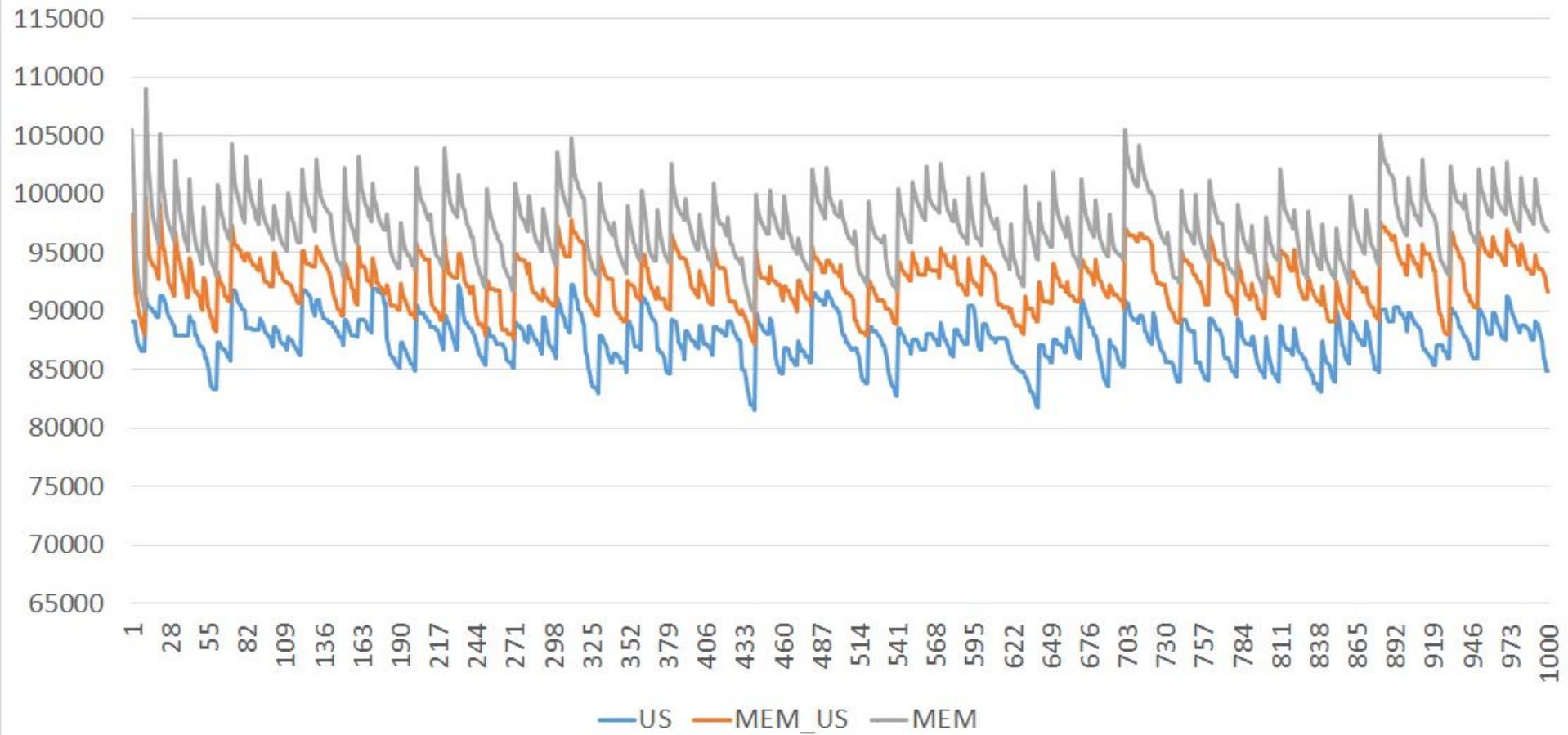
# Joinville 78 - freq 10 - mag 0.75



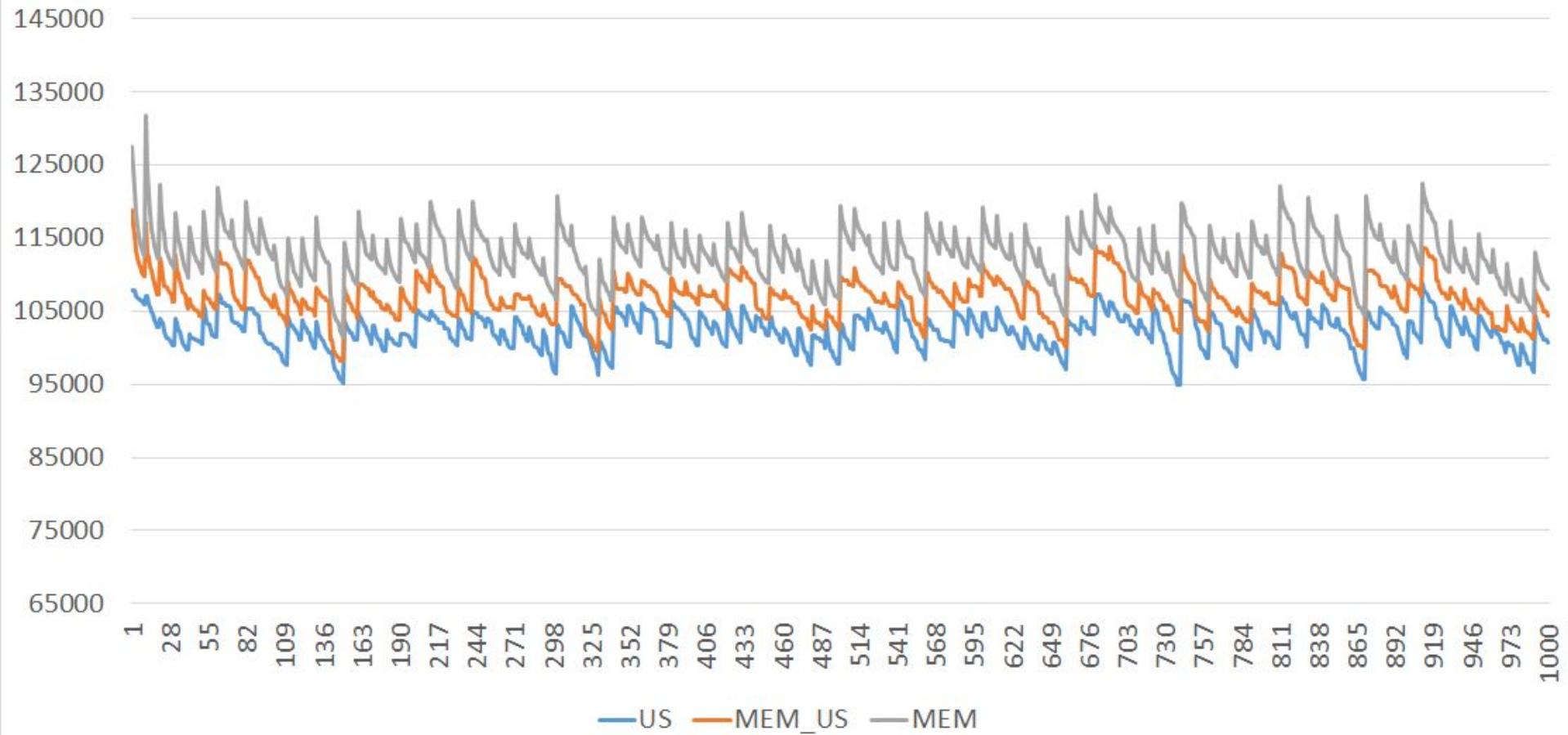
# Joinville 125 - freq 10 - mag 0.1



### Joinville 125 - freq 10 - mag 0.5

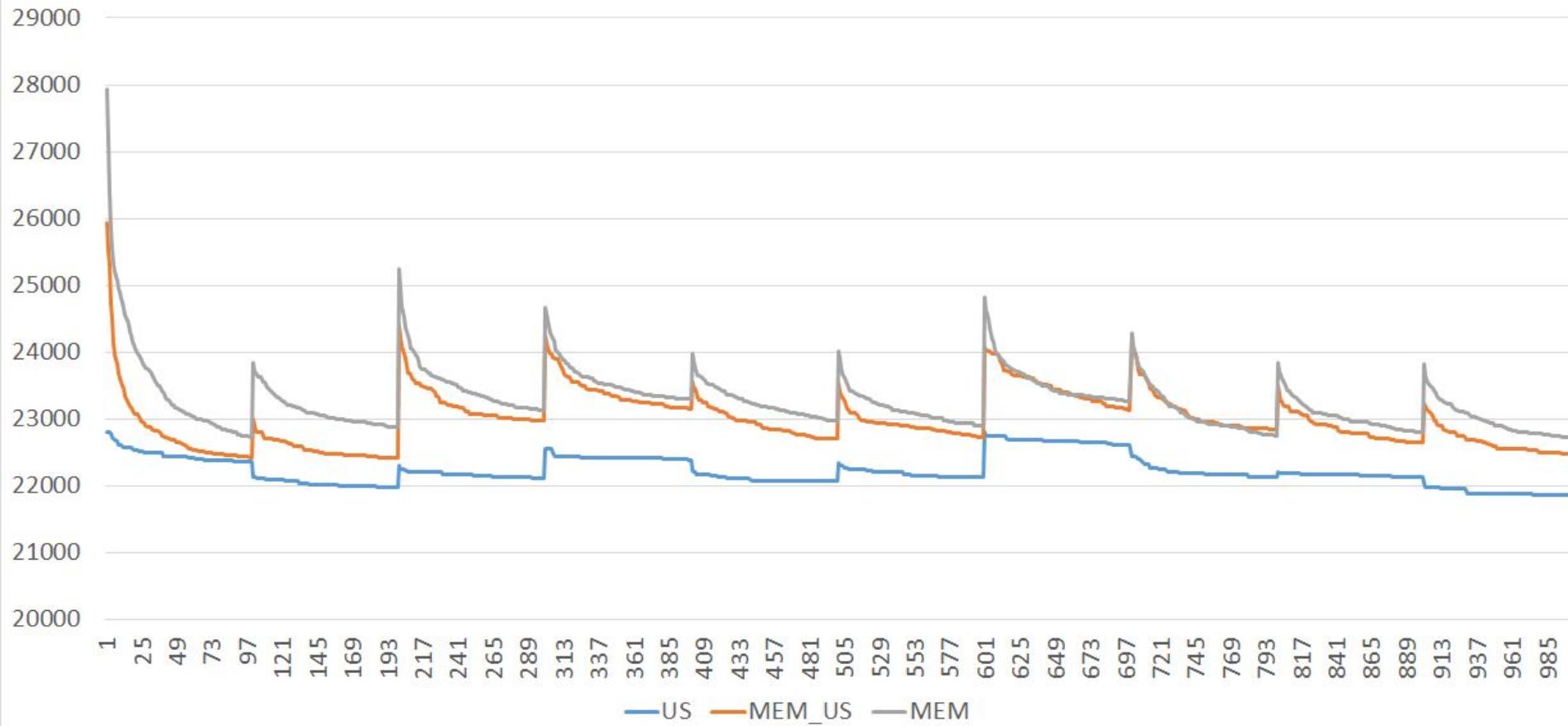


# Joinville 125 - freq 10 - mag 0.75

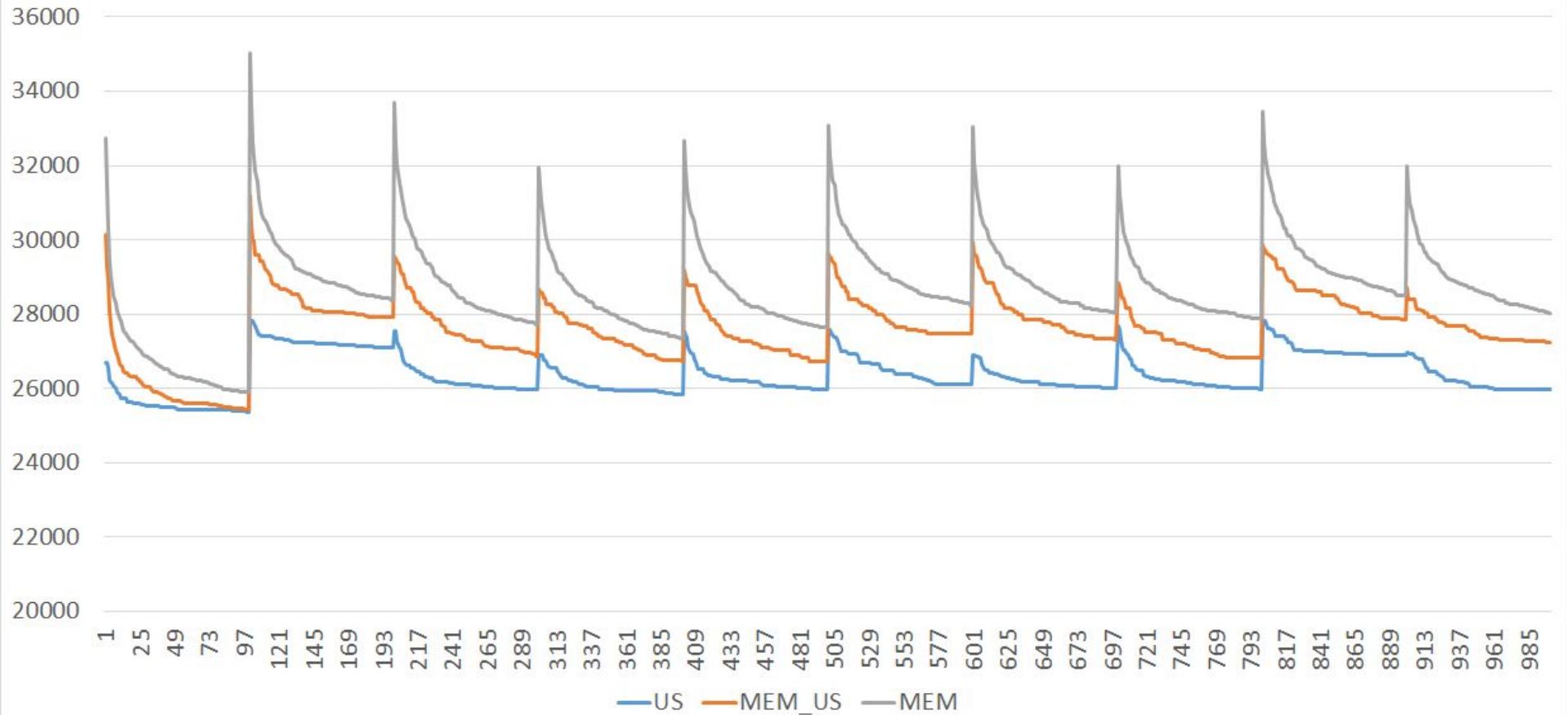


Frequênciā = 100

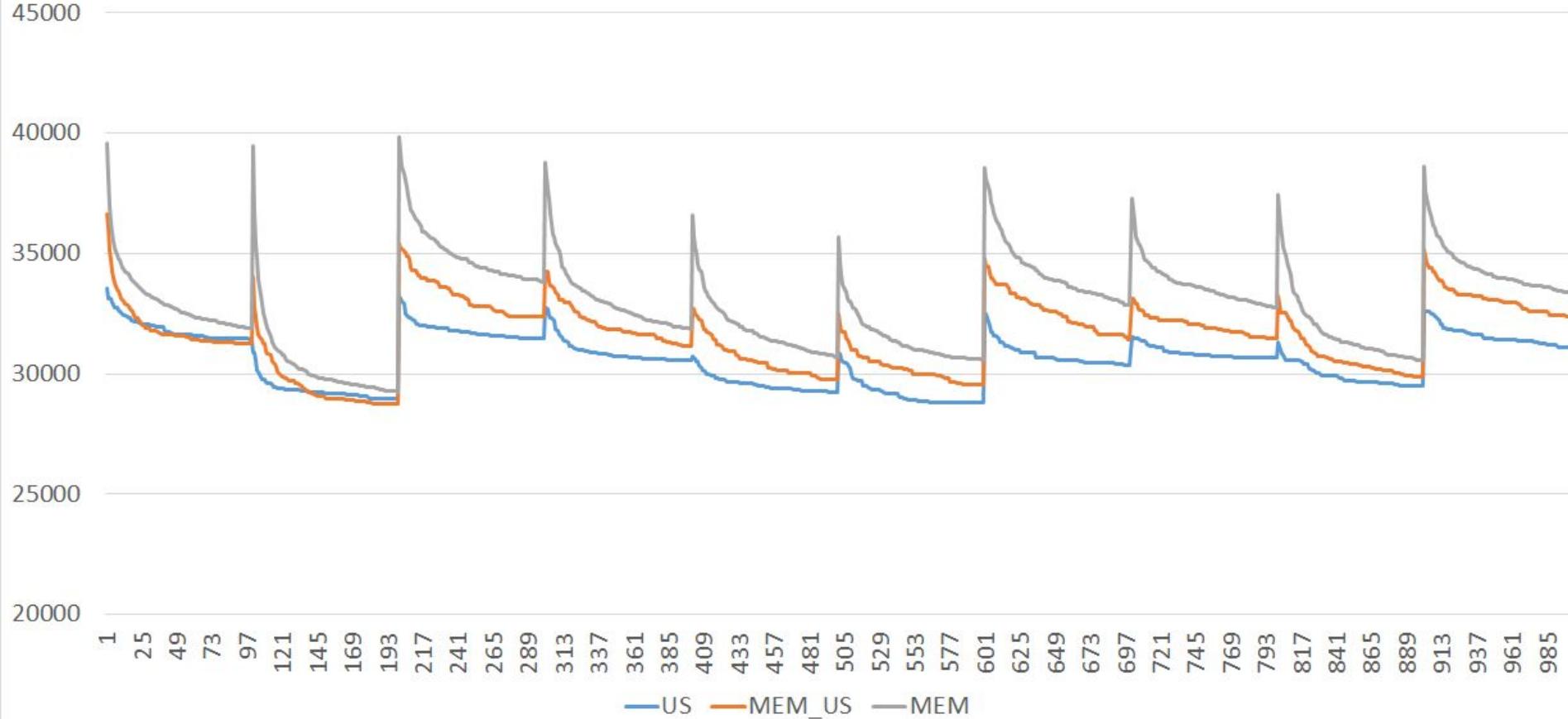
### KroA100 - freq 100 - mag 0.1



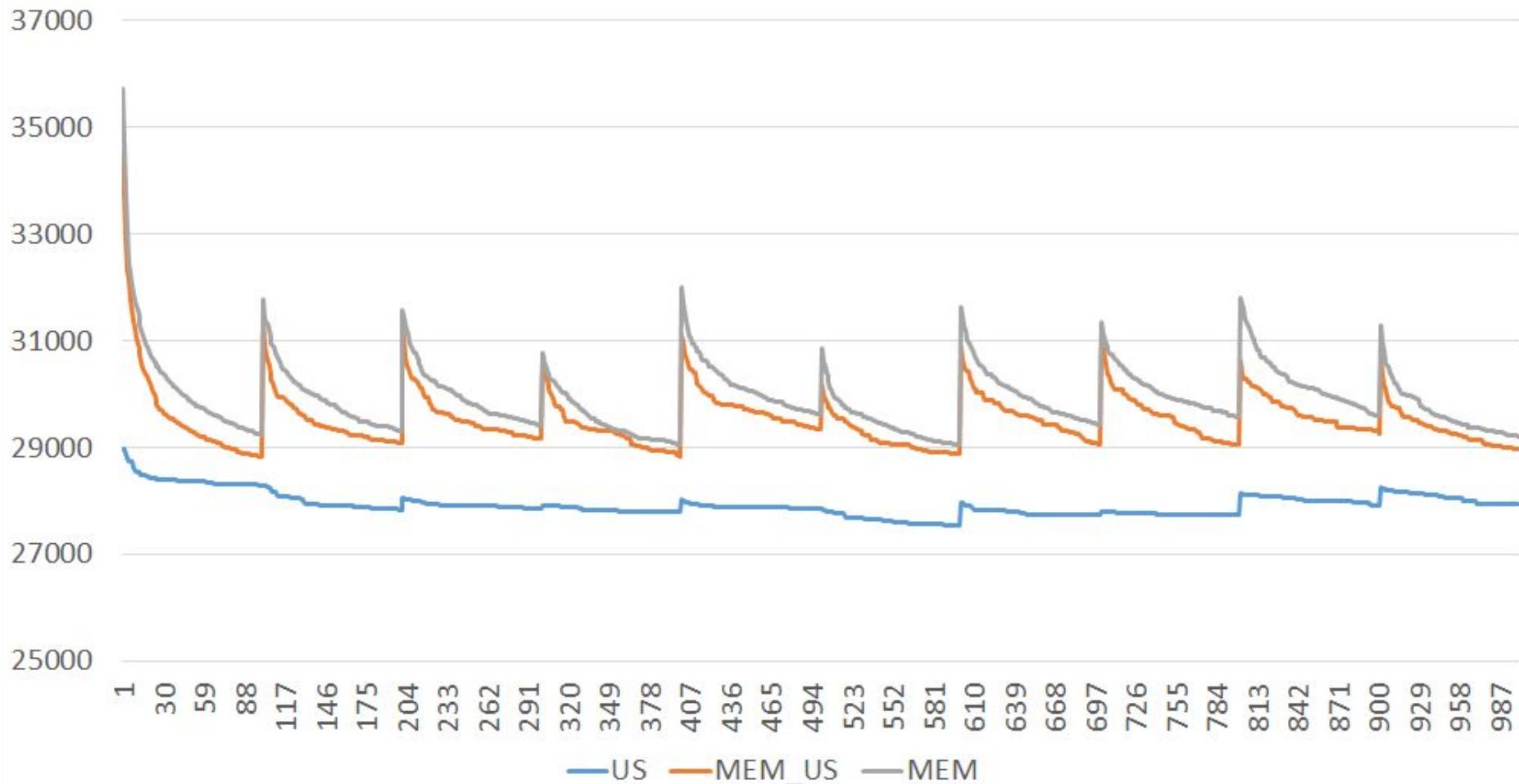
### KroA100 - freq 100 - mag 0.5



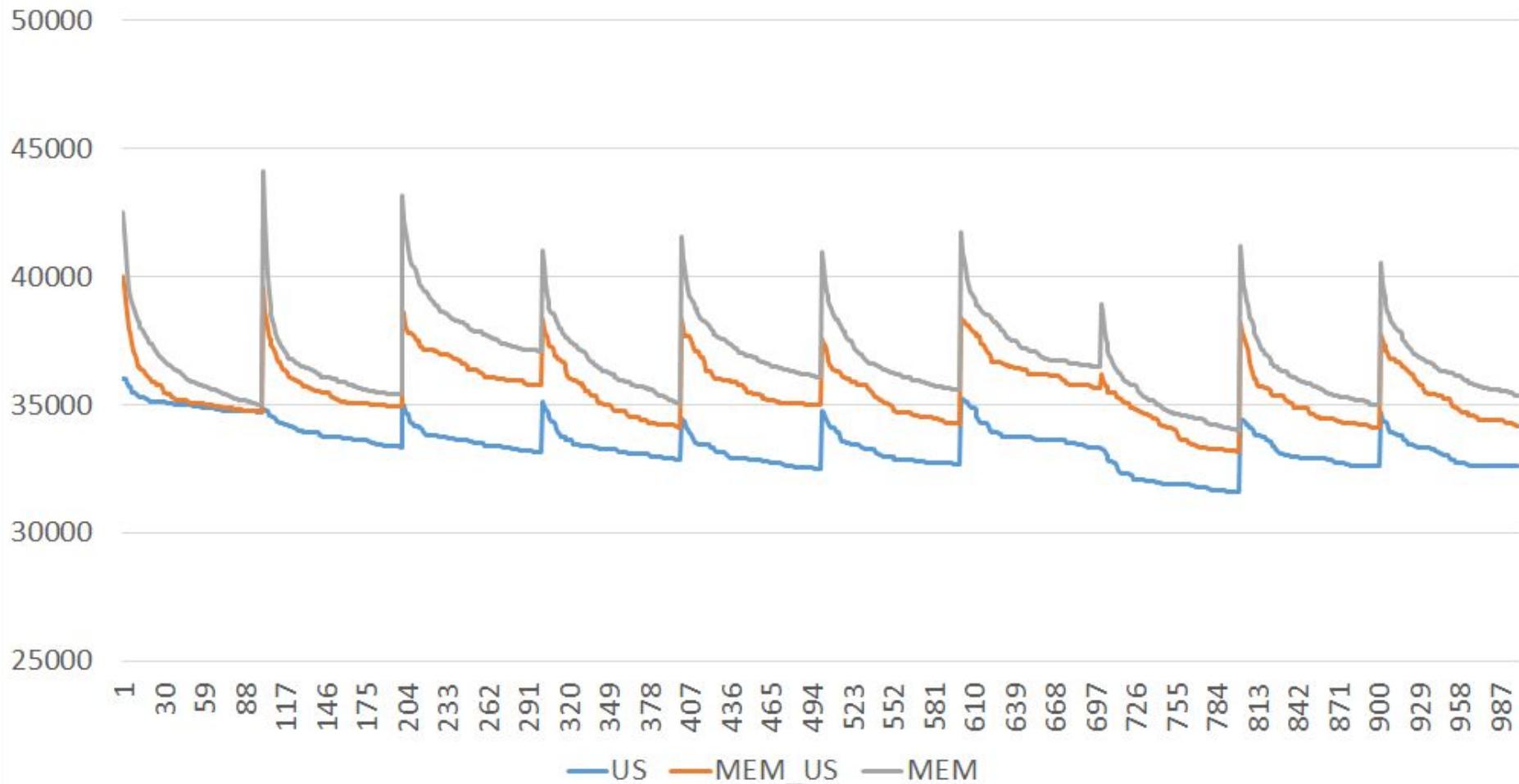
### KroA100 - freq 100 - mag 0.75



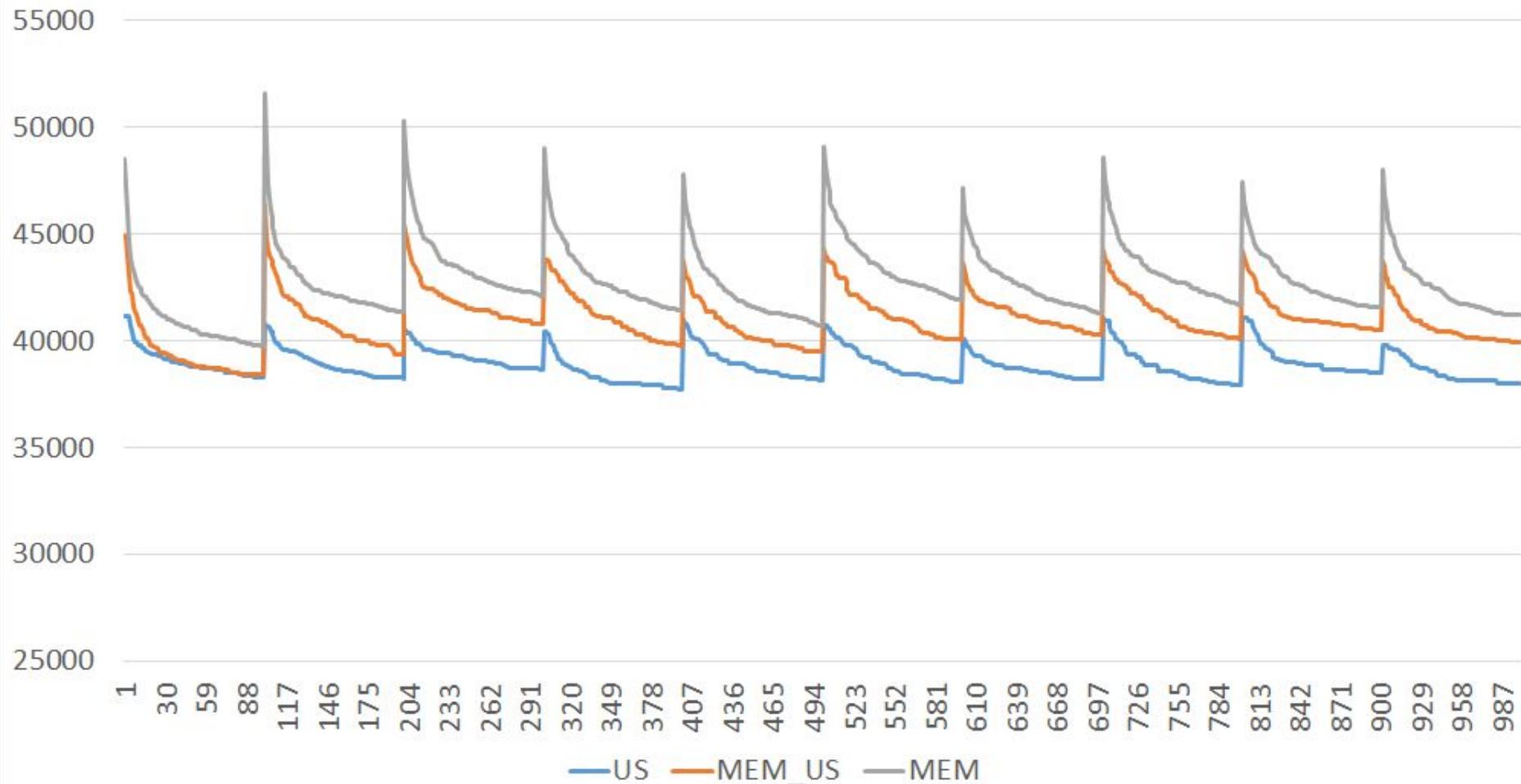
# KroA150 - freq 100 - mag 0.1



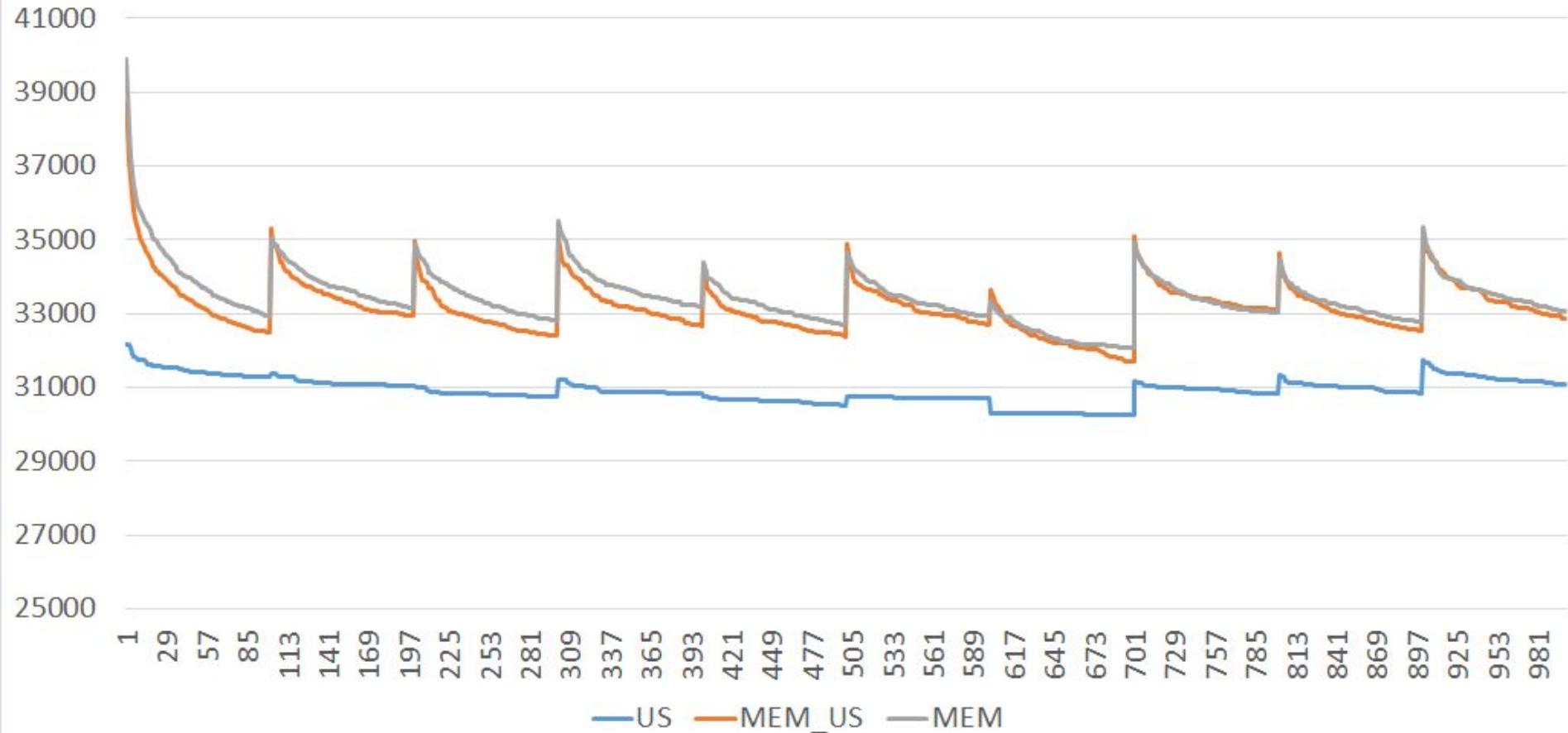
# KroA150 - freq 100 - mag 0.5



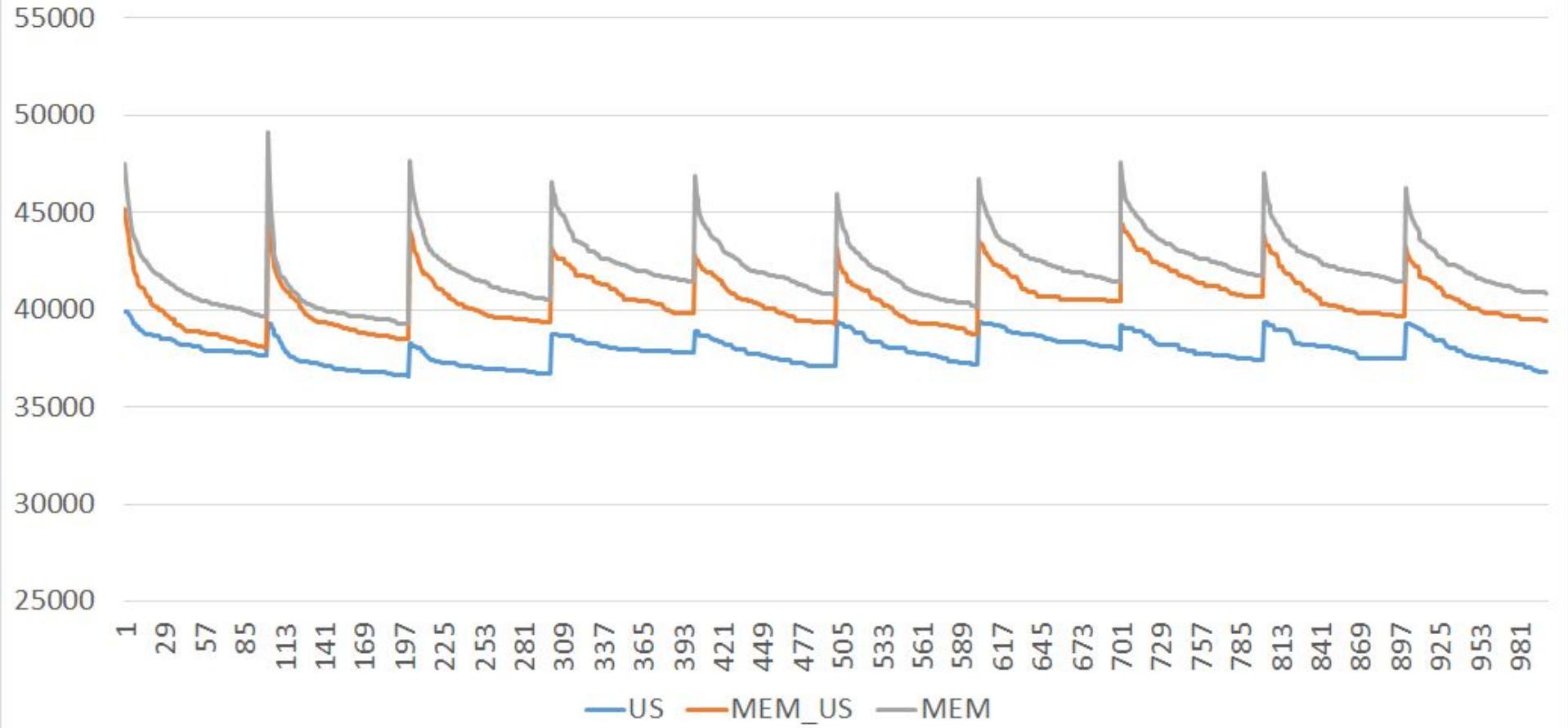
# KroA150 - freq 100 - mag 0.75



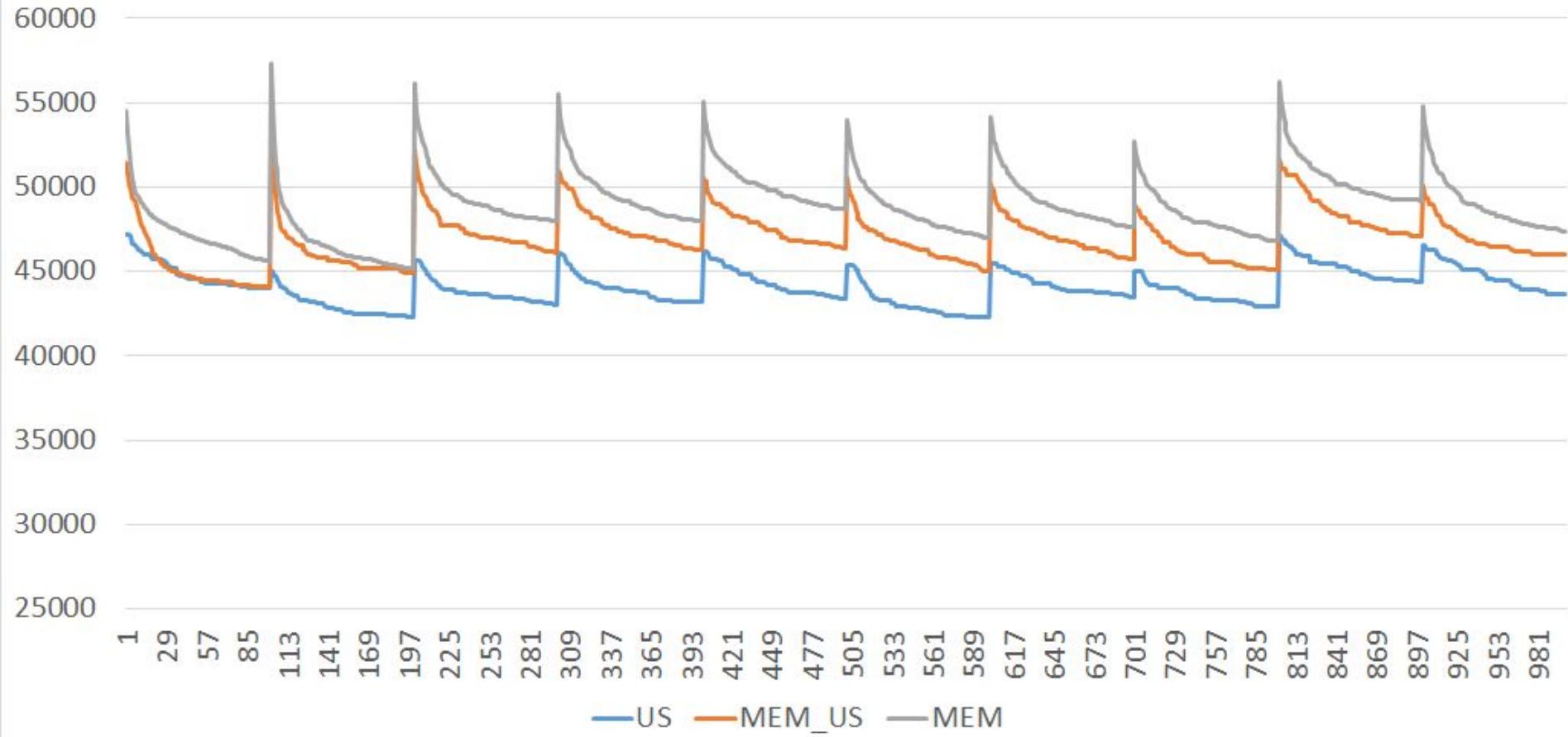
# KroA200 - freq 100 - mag 0.1



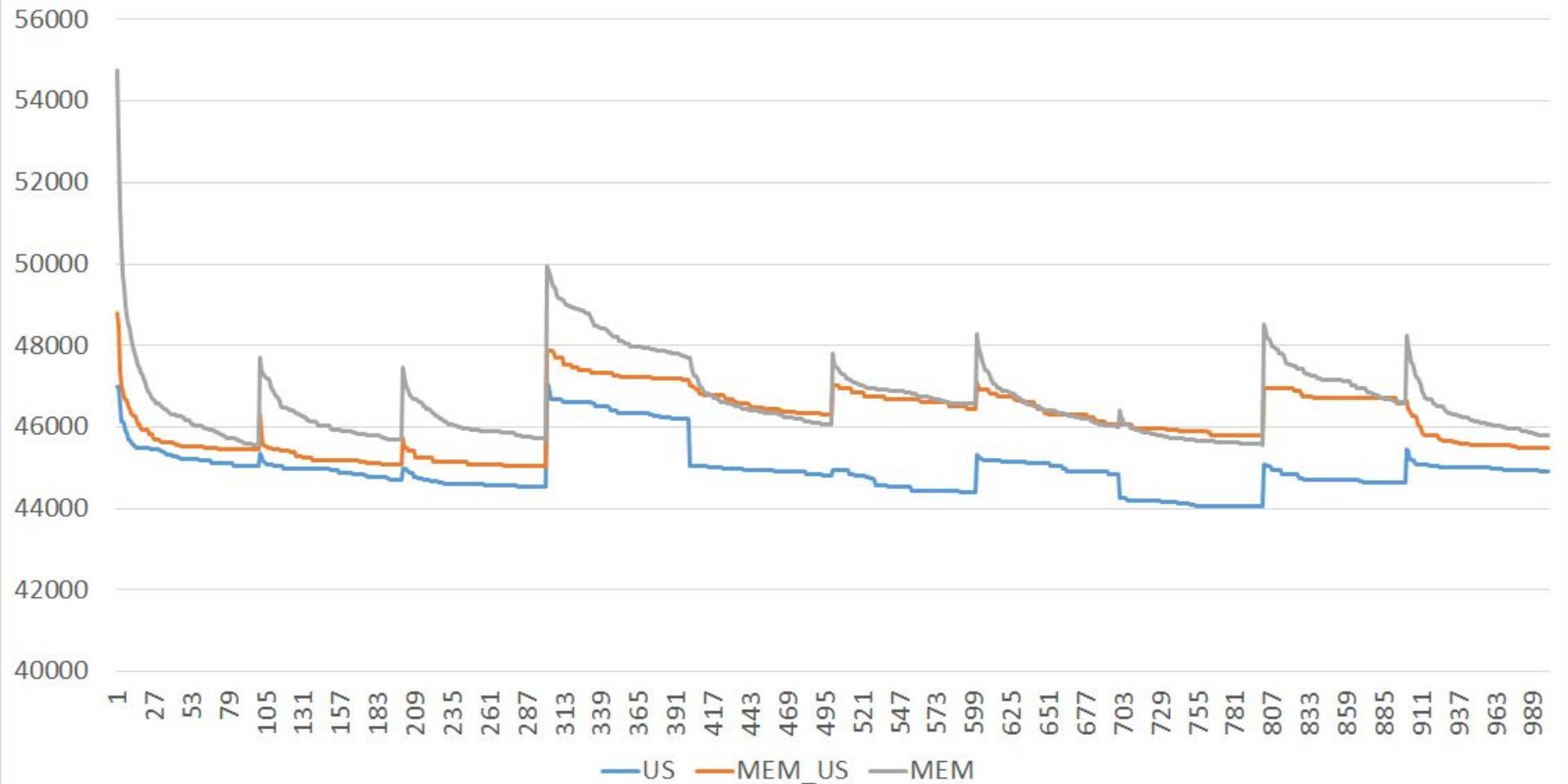
# KroA200 - freq 100 - mag 0.5



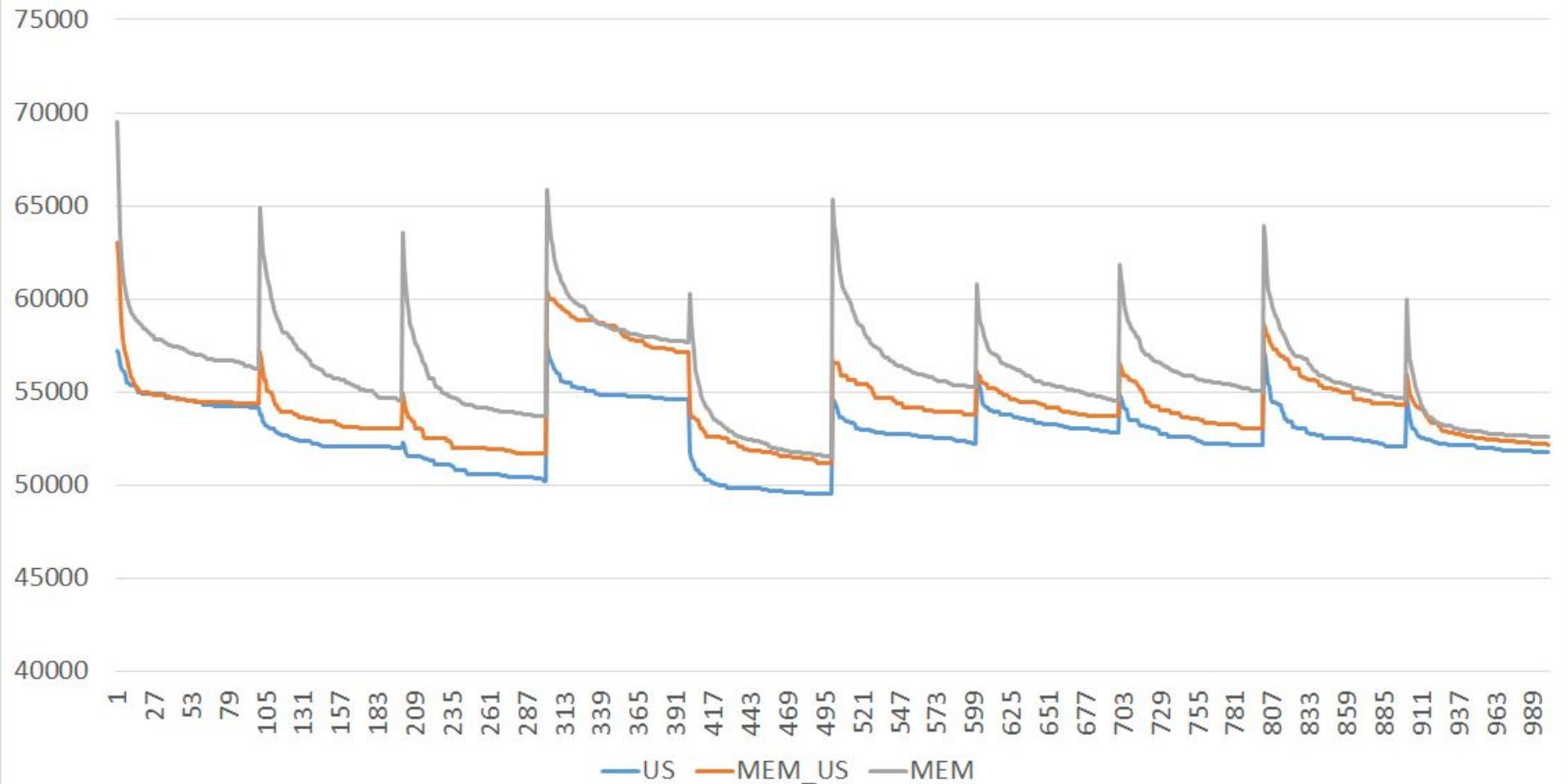
# KroA200 - freq 100 - mag 0.75



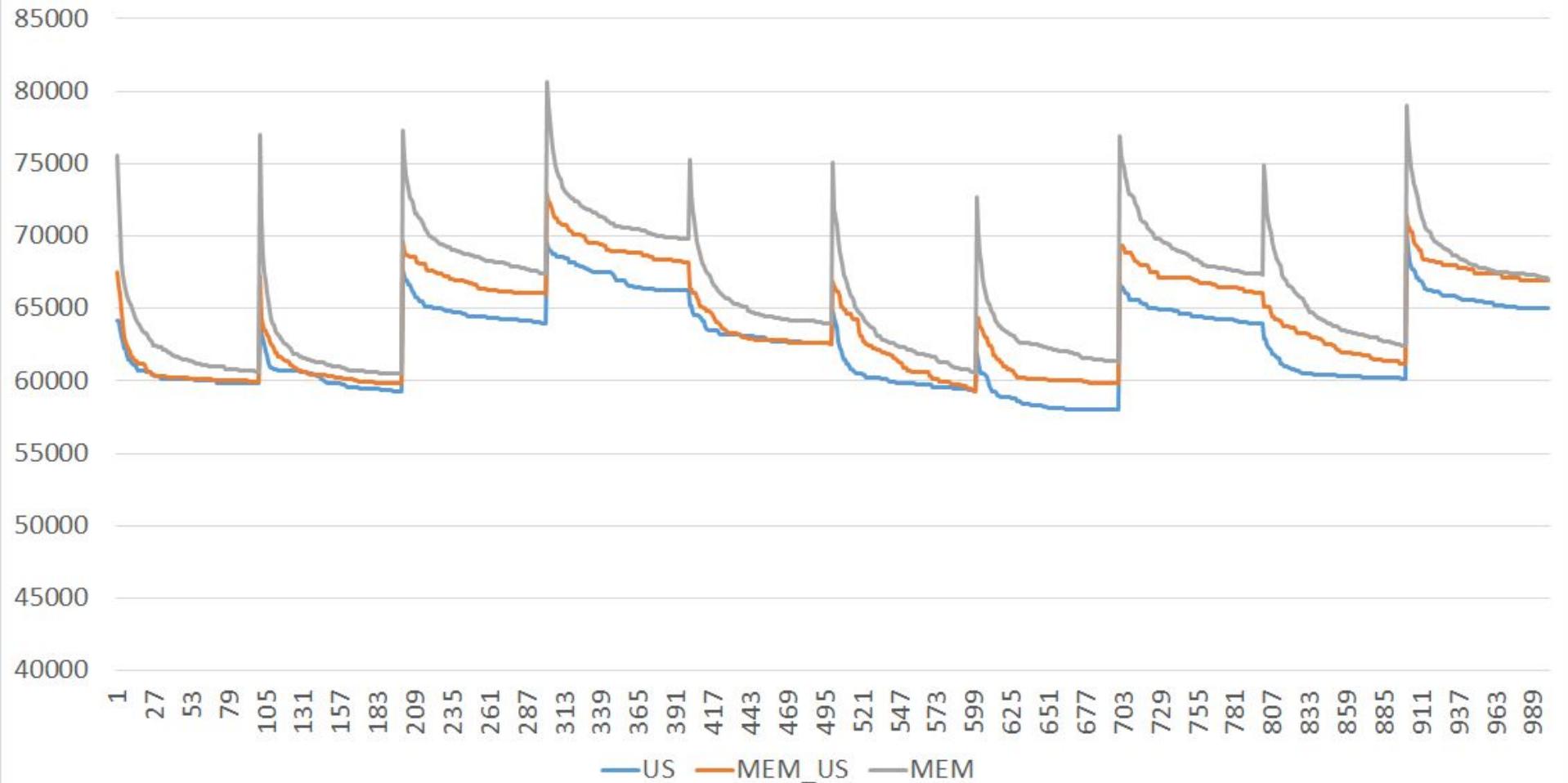
# Joinville 46 - freq 100 - mag 0.1



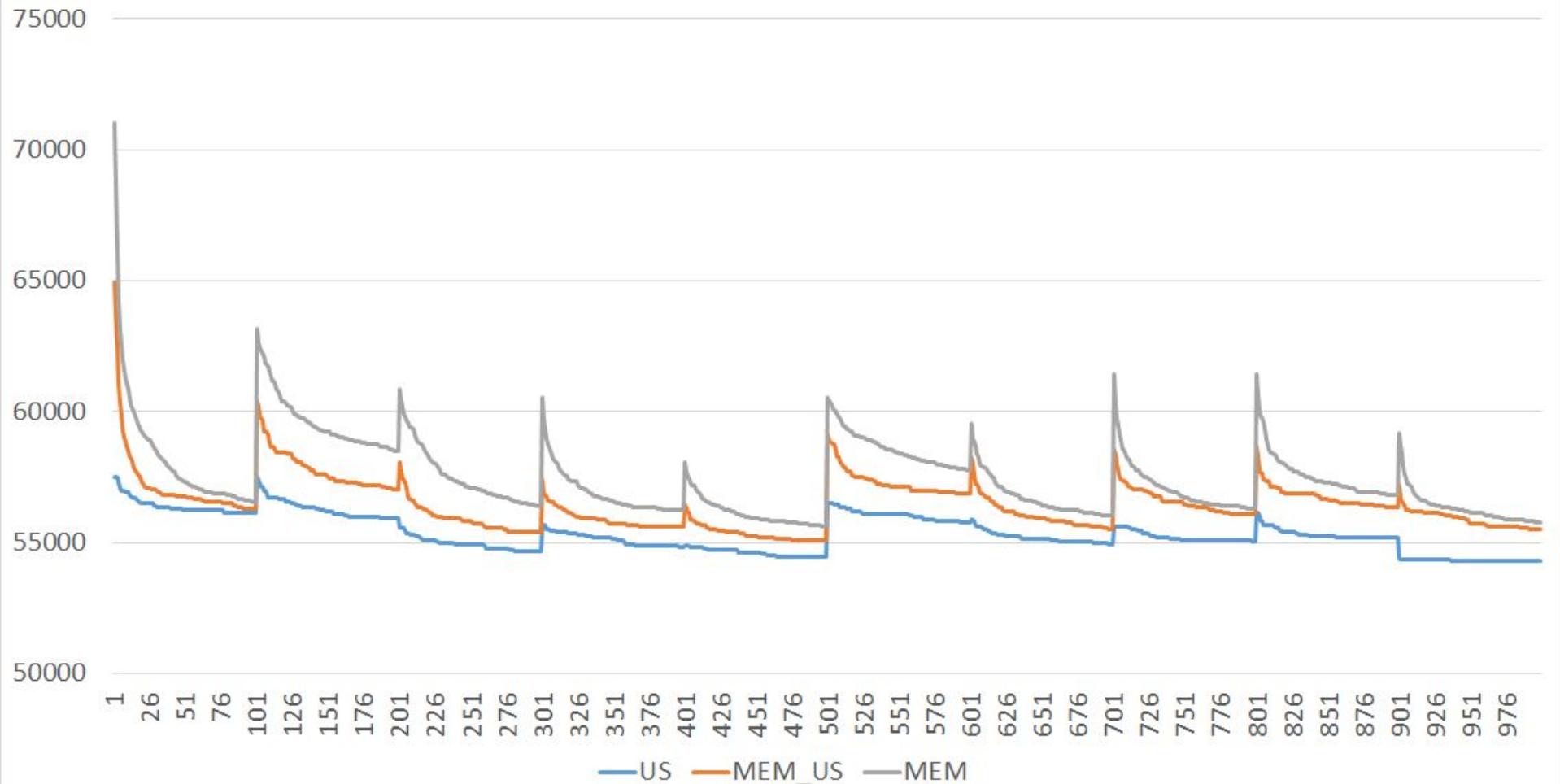
# Joinville 46 - freq 100 - mag 0.5



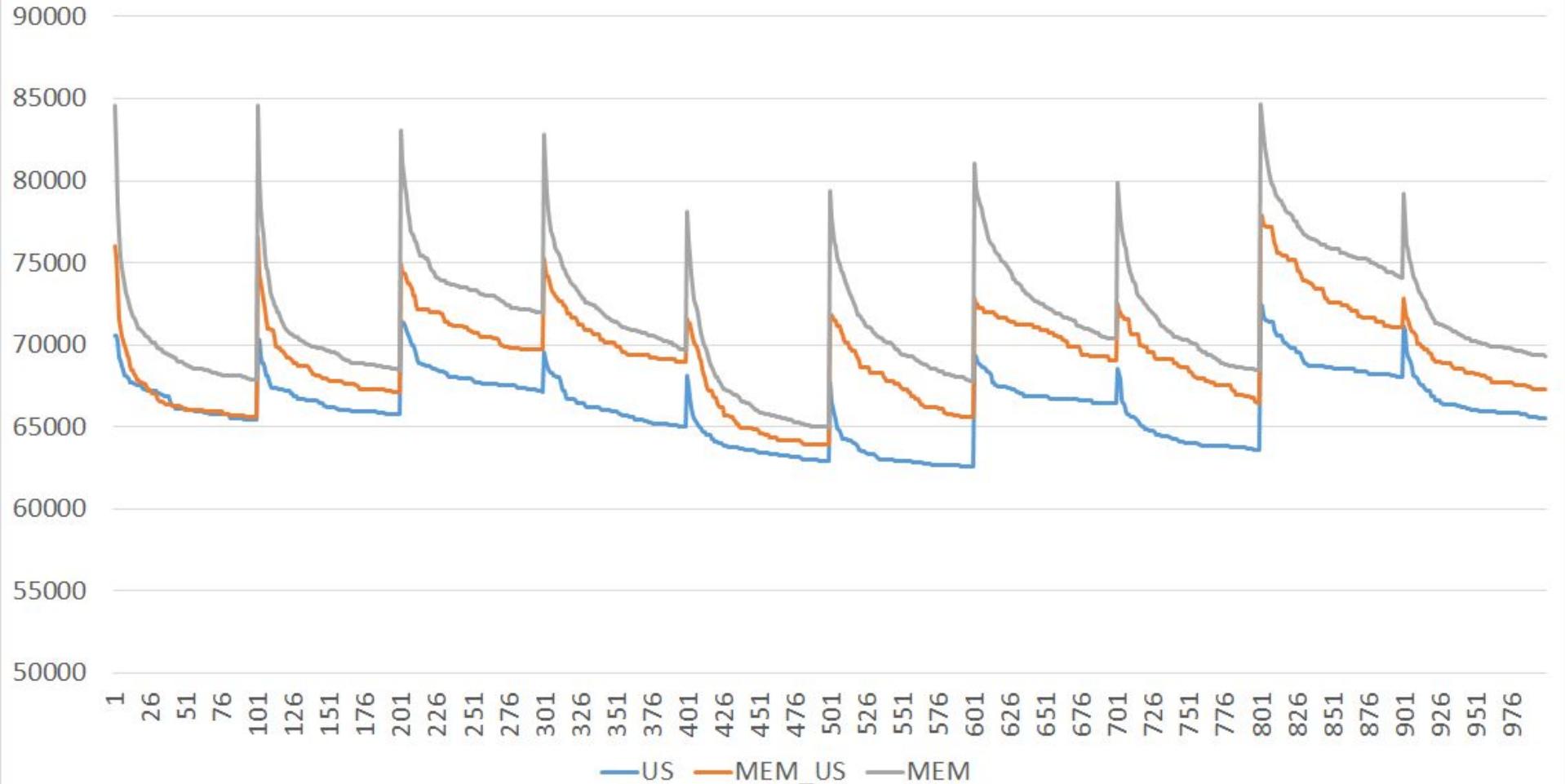
# Joinville 46 - freq 100 - mag 0.75



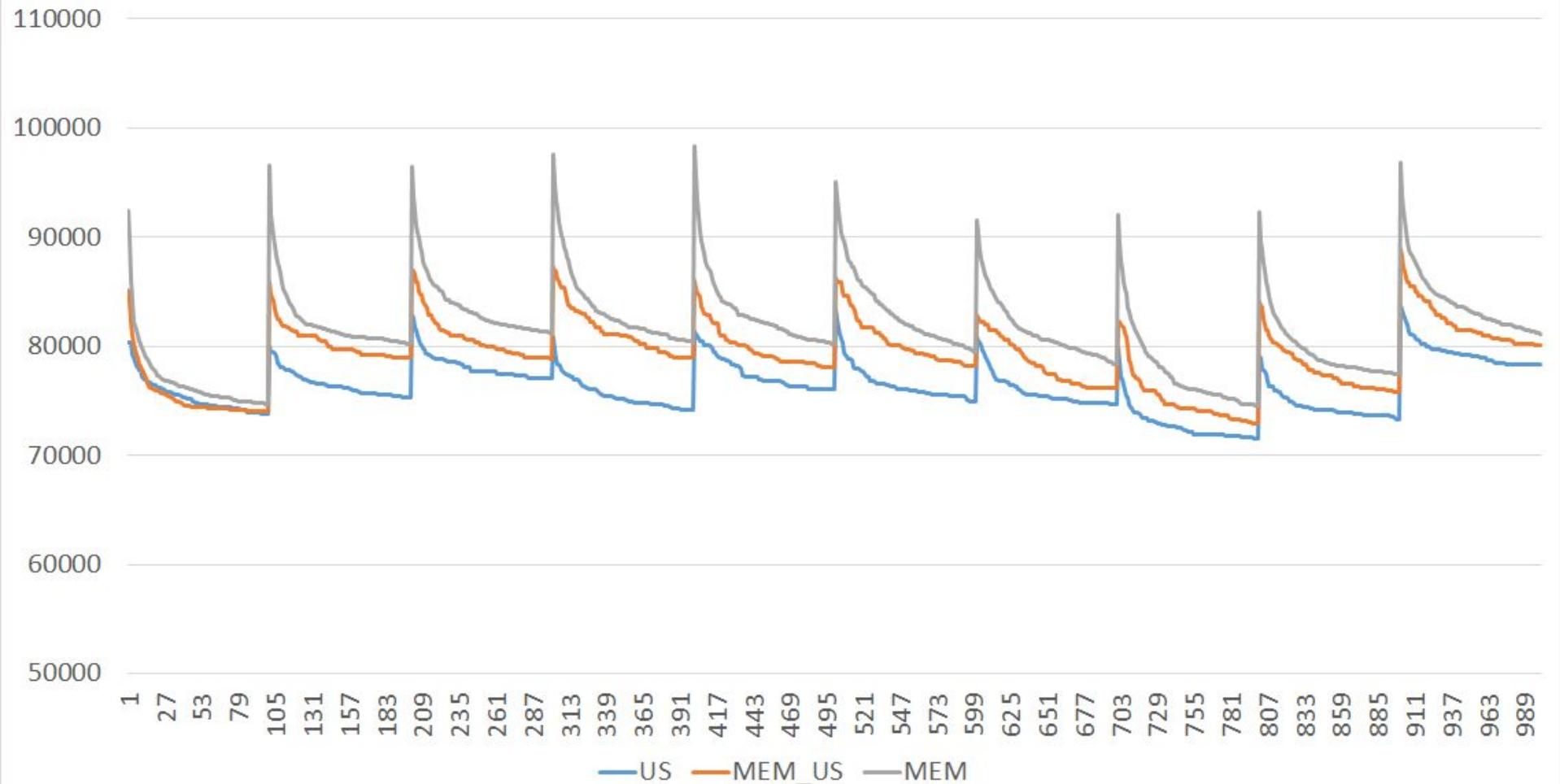
# Joinville 78 - freq 100 - mag 0.1



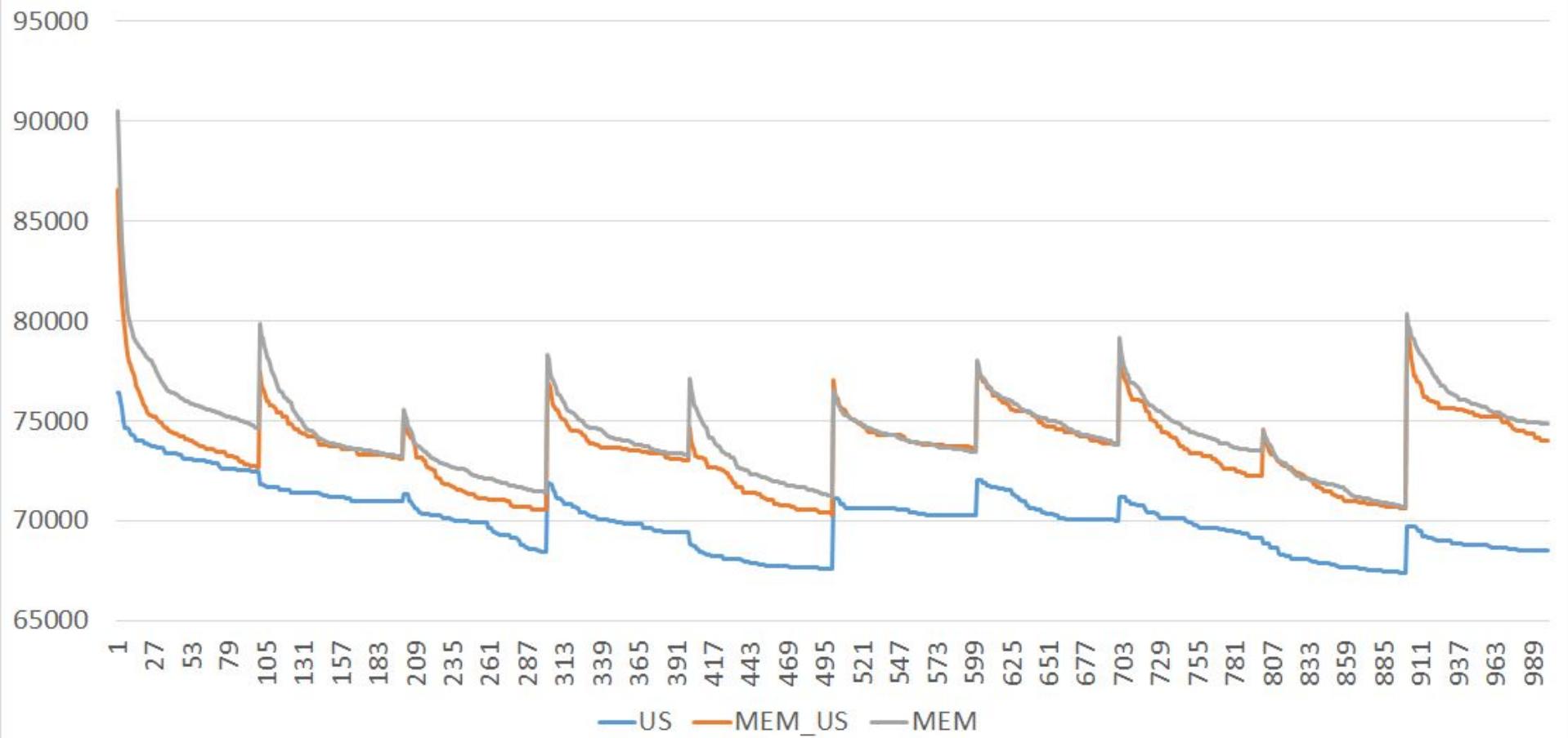
# Joinville 78 - freq 100 - mag 0.5



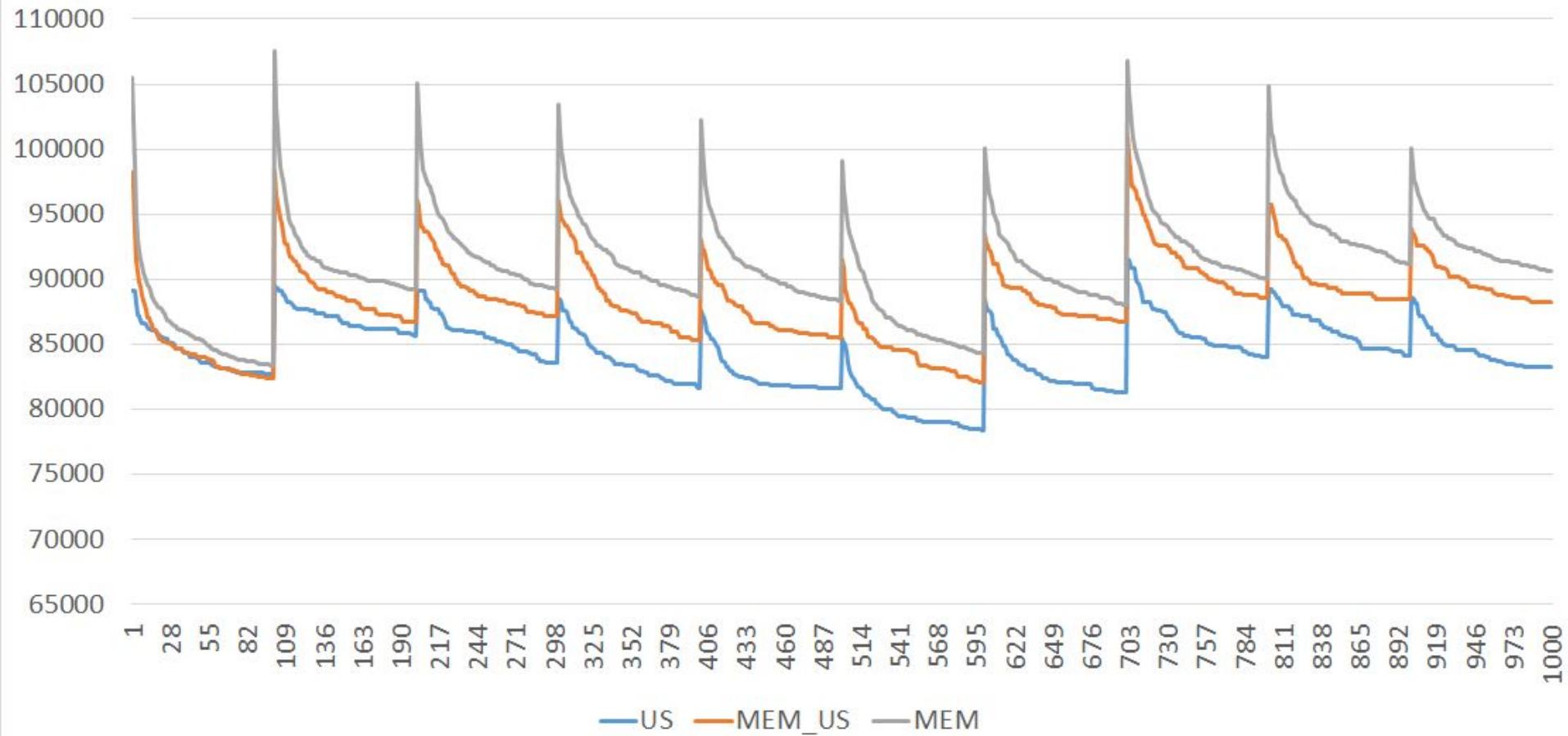
# Joinville 78 - freq 100 - mag 0.75



# Joinville 125 - freq 100 - mag 0.1



# Joinville 125 - freq 100 - mag 0.5



# Joinville 125 - freq 100 - mag 0.75

