

```
{K}std::set = std::set<uint{K}_t>, {K}uVEB = VanEmdeBoas<{K}>, {K}VEB = VanEmdeBoas<{K},  
    int{K}_t>, uVEB32 = VanEmdeBoas32<>, 32uVEBL = VanEmdeBoasLocked<32>, uVEB32L =  
    VanEmdeBoas32Locked<>, uVEB32LT = VanEmdeBoas32LockedTop<>, uVEB32LFG =  
    VanEmdeBoas32LockedFineGrained<>, uVEB32LL = VanEmdeBoas32Lockless.
```

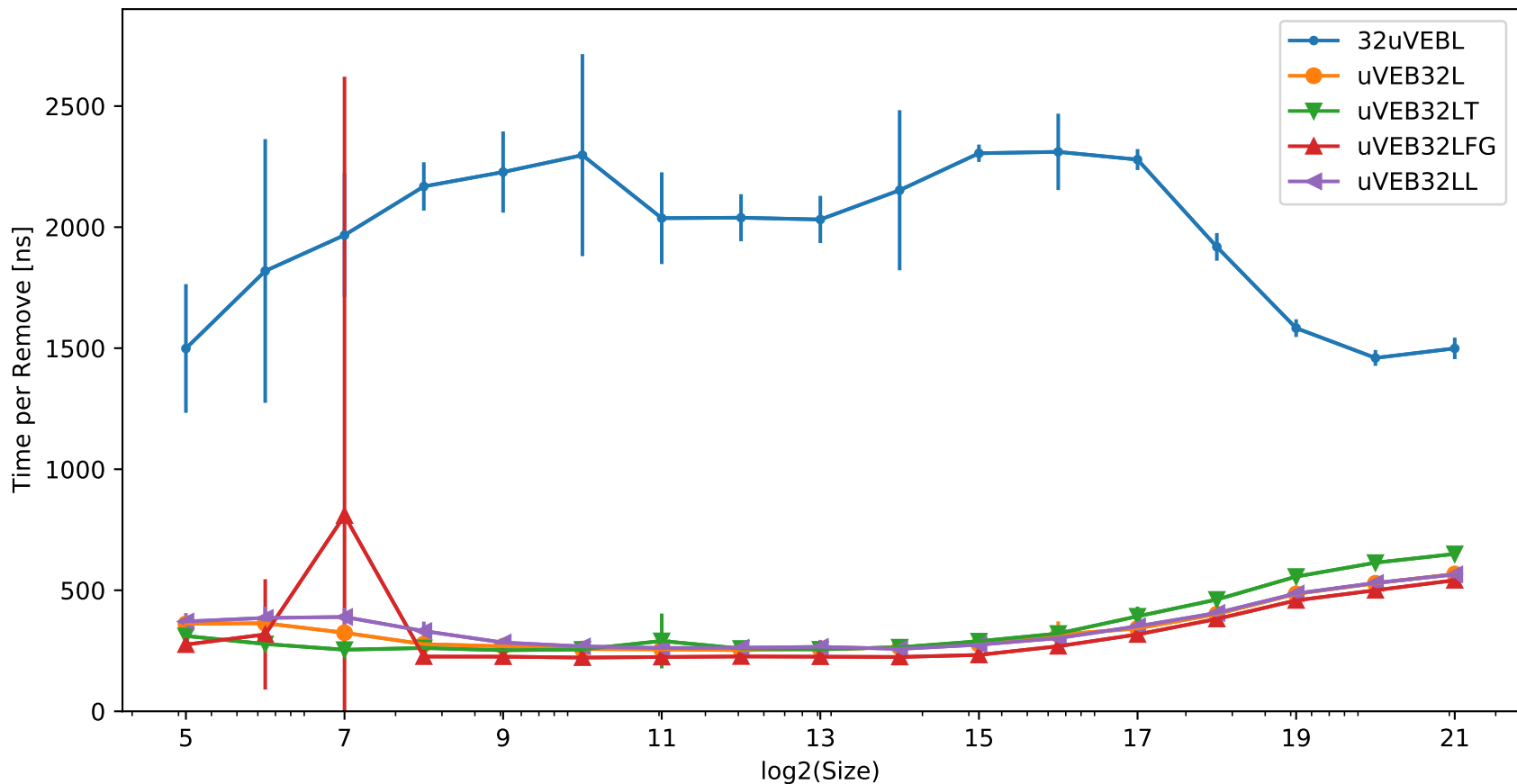
No #defines => sf::contention\_free\_shared\_mutex is used often; also bytell\_hash\_map by Malte Skarupke is used for VanEmdeBoas and VanEmdeBoasLocked (not VanEmdeBoas32 and its parallel variants)  
Random distributions: uniform, cluster = random placed clusters with 1000 succeeding elements, normal = normal distribution with mean  $\sim 0/2^{31}$  for signed/unsigned and std  $(2^{31})/10$ , incProb = linear increasing probability where the smallest value has probability 0, decProb = linear decreasing probability where the largest value has probability 0

The operation is parallelized with OpenMP (static scheduling) and the time until completion is measured. Unlike for the sequential plots, the inserted elements are shuffled before insertion. This is relevant for the cluster distribution since it increases the probability that more than one thread tries to access the same bottom data structure at the same time because without shuffling most clusters are inserted by a single thread since the scheduling is static.

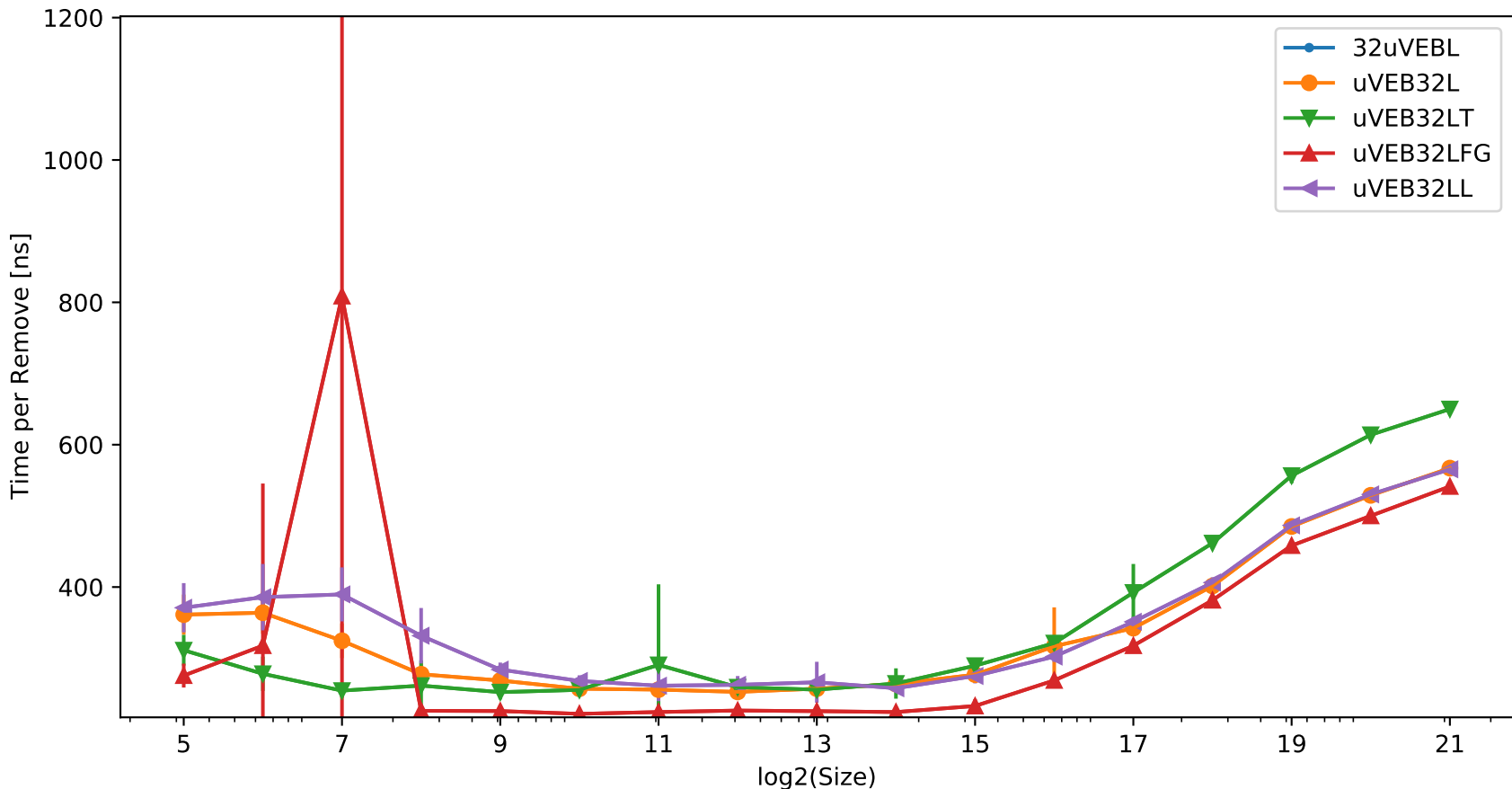
There are ten iterations for each data point.

Hardware: i7-7700HQ, 16GB DDR4 Windows Laptop

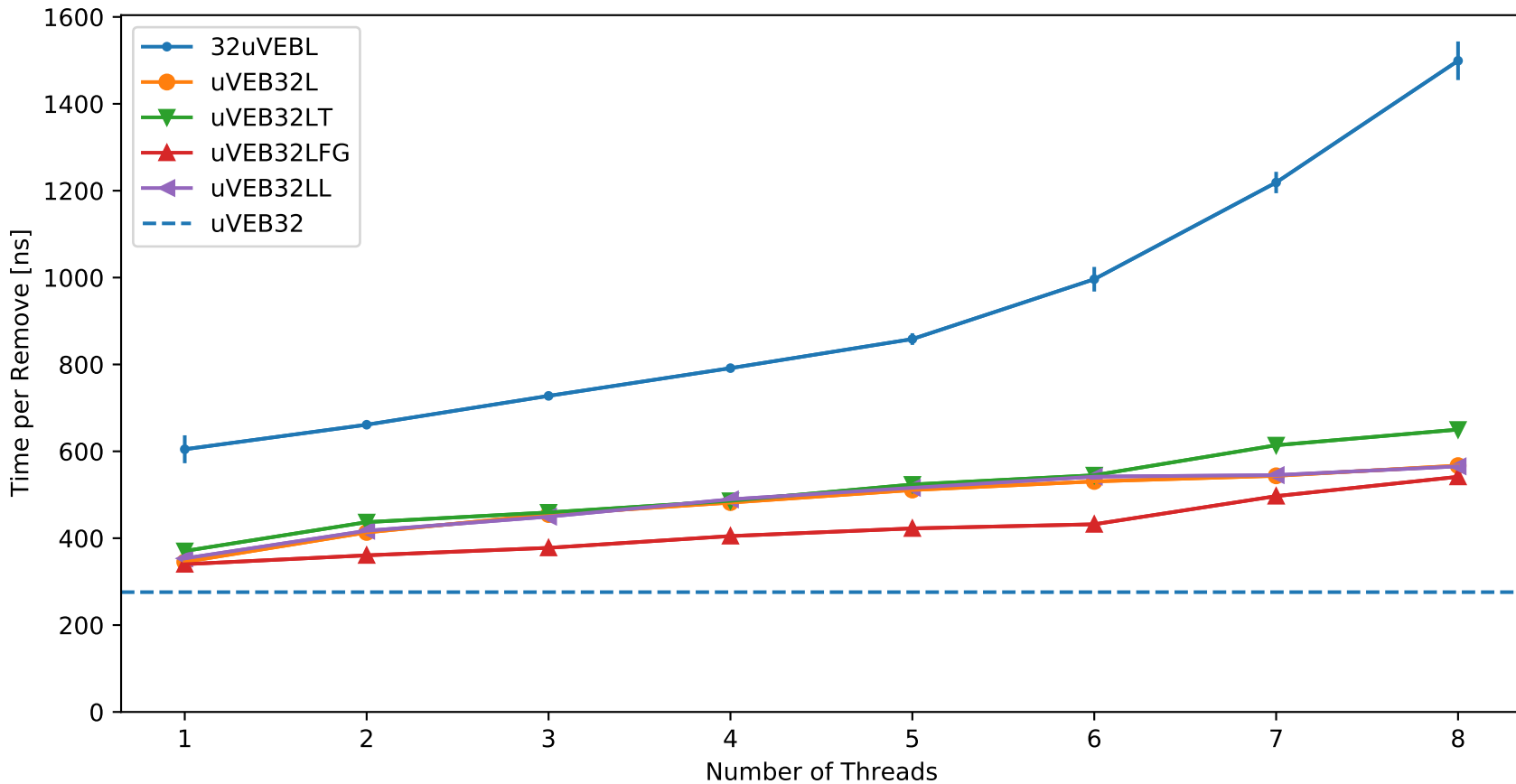
Time to Remove 'Size' Elements Parallel (uniform distribution; 8 Threads)



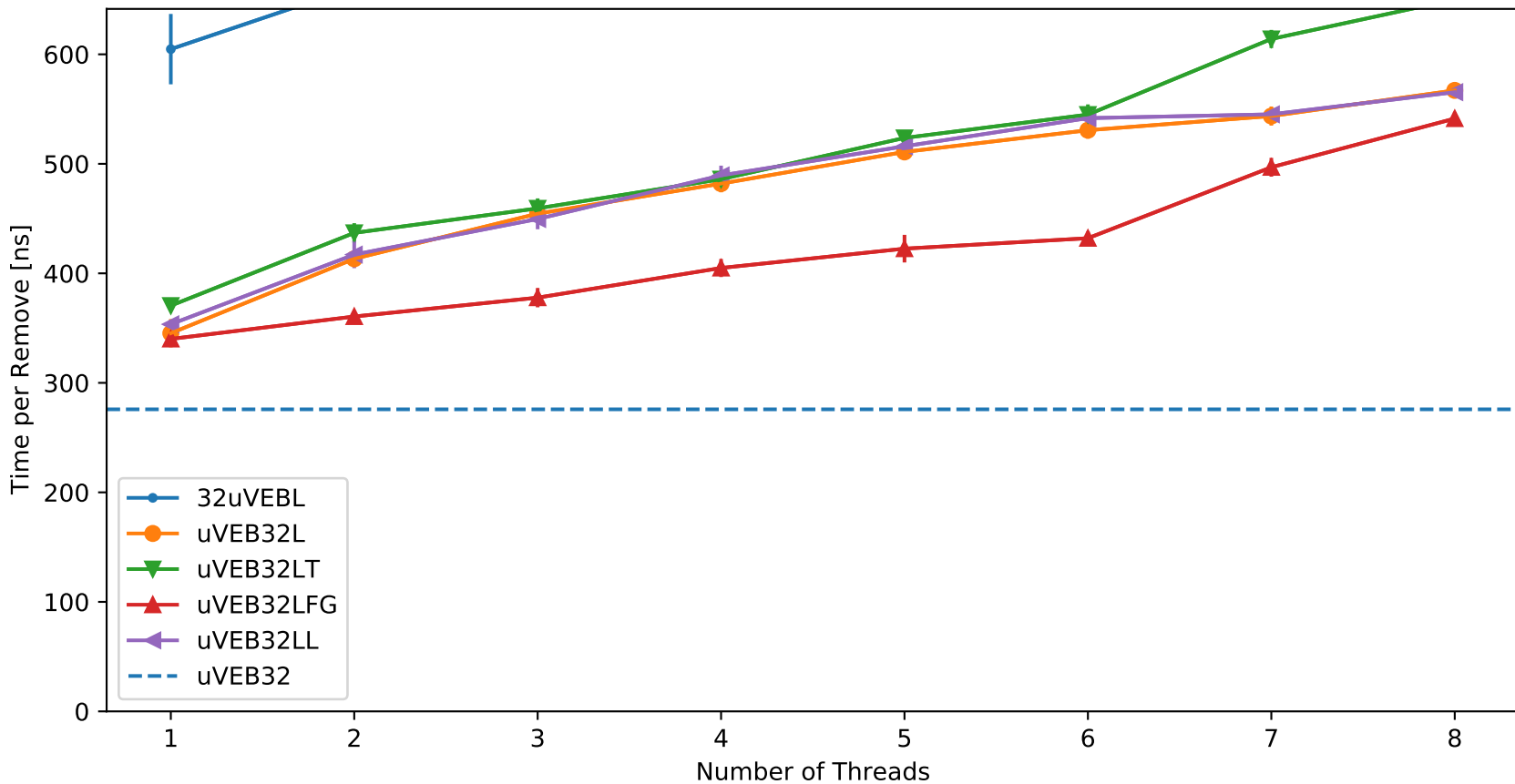
Time to Remove 'Size' Elements Parallel (Zoomed in; uniform distribution; 8 Threads)



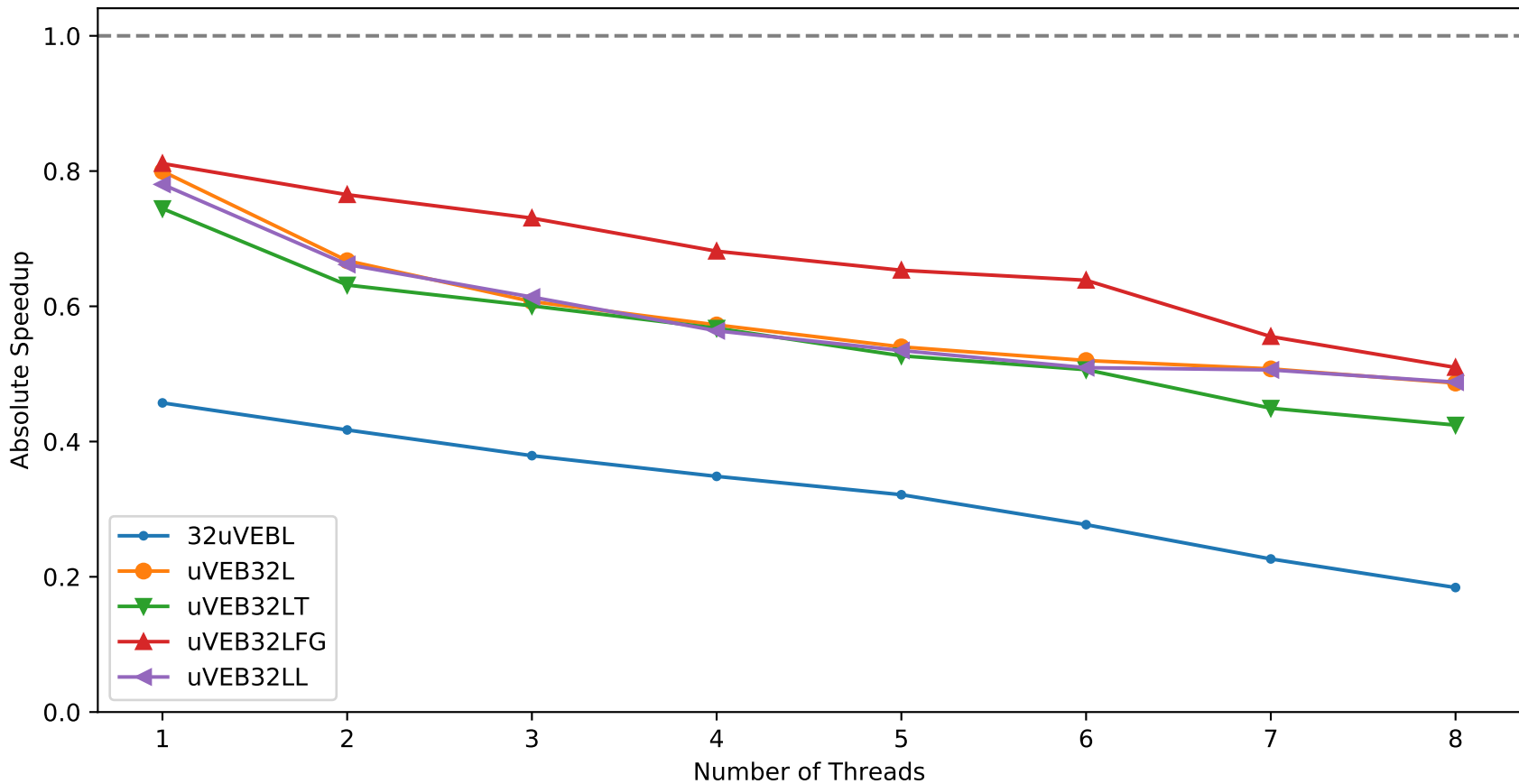
Time to Remove 'Size' Elements Parallel (uniform distribution; 2097152 Elements)



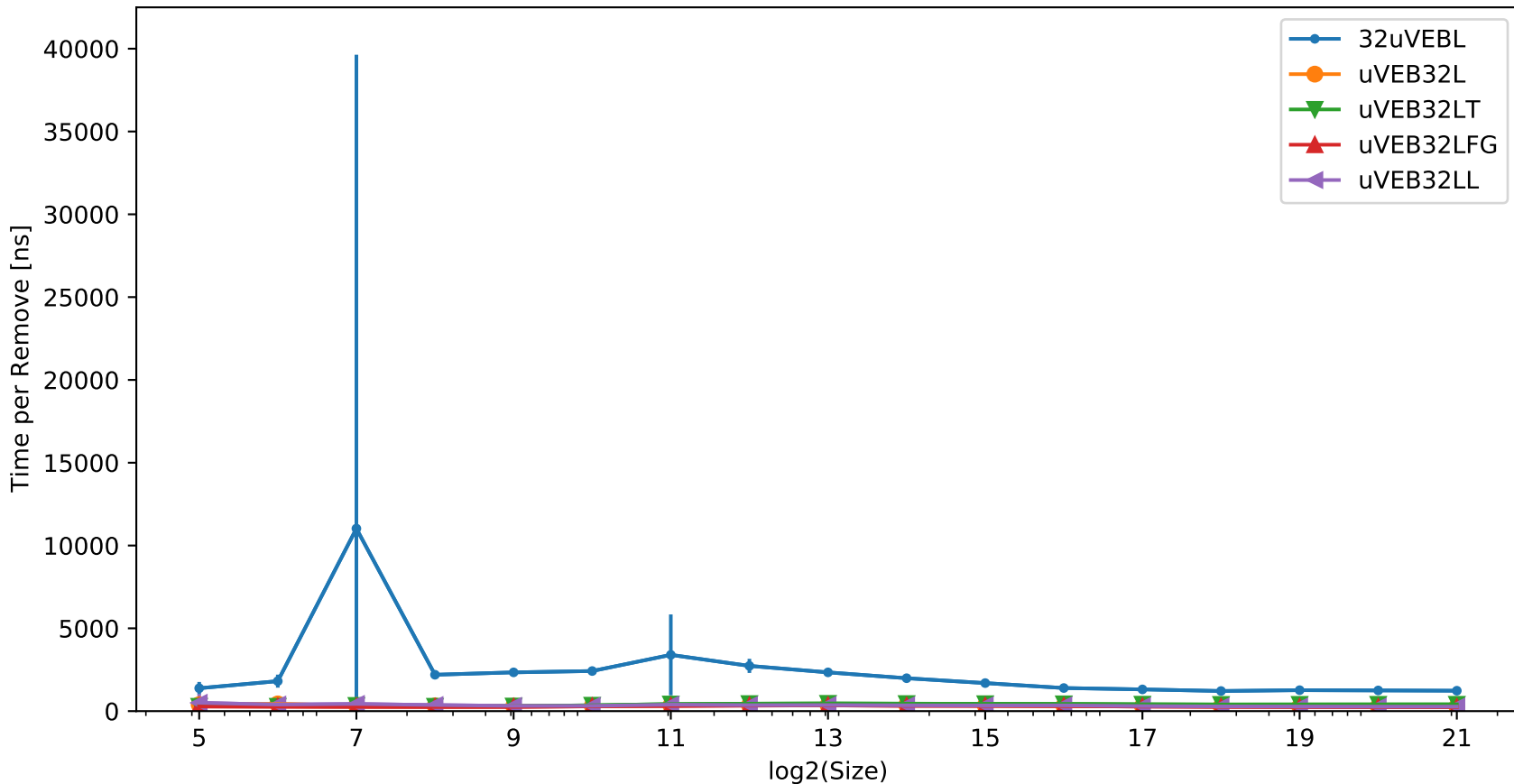
Time to Remove 'Size' Elements Parallel (Zoomed in; uniform distribution; 2097152 Elements)



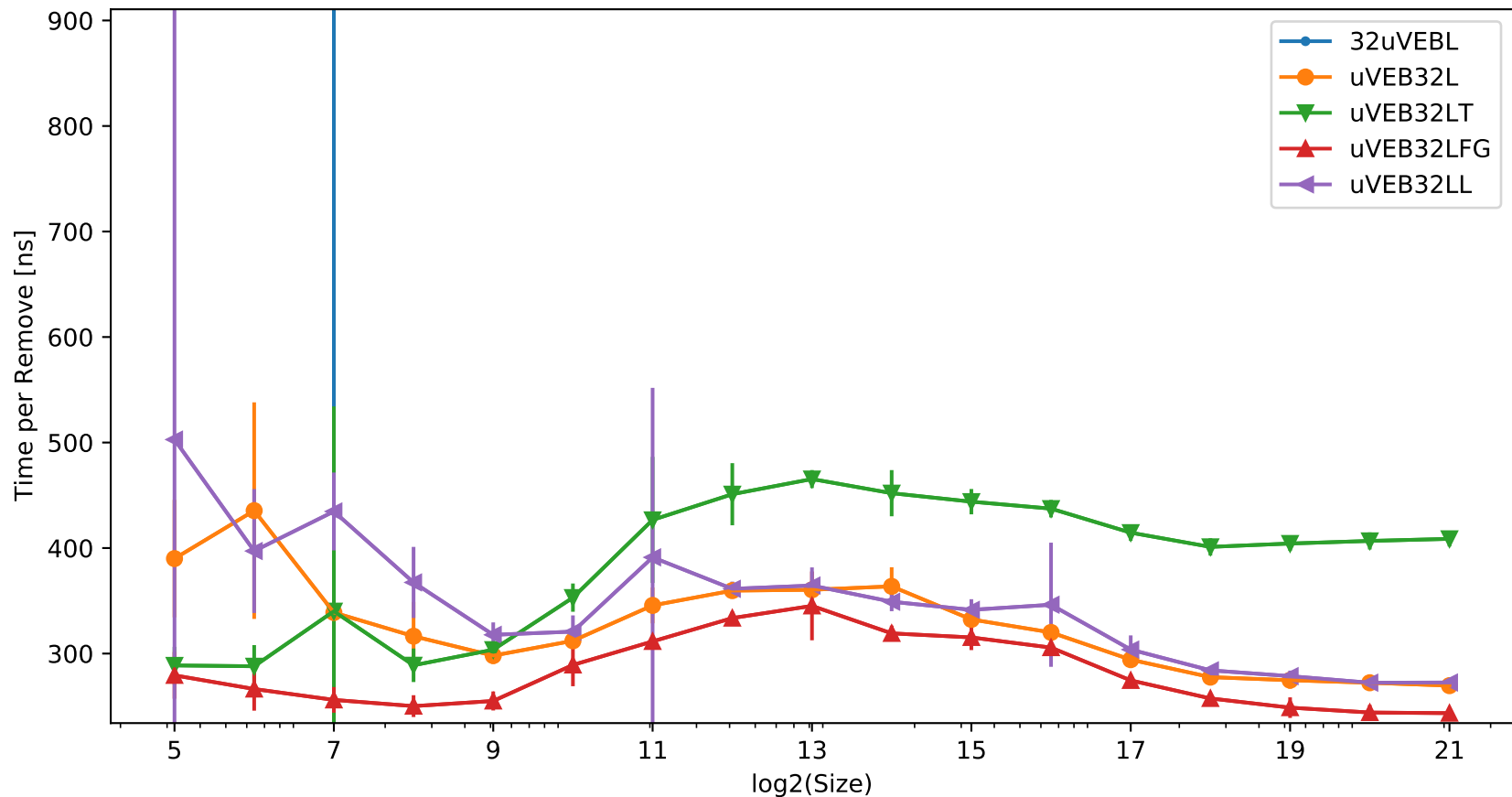
Speedup over uVEB32 to Remove 'Size' Elements Parallel (uniform distribution; 2097152 Elements)



Time to Remove 'Size' Elements Parallel (cluster distribution; 8 Threads)

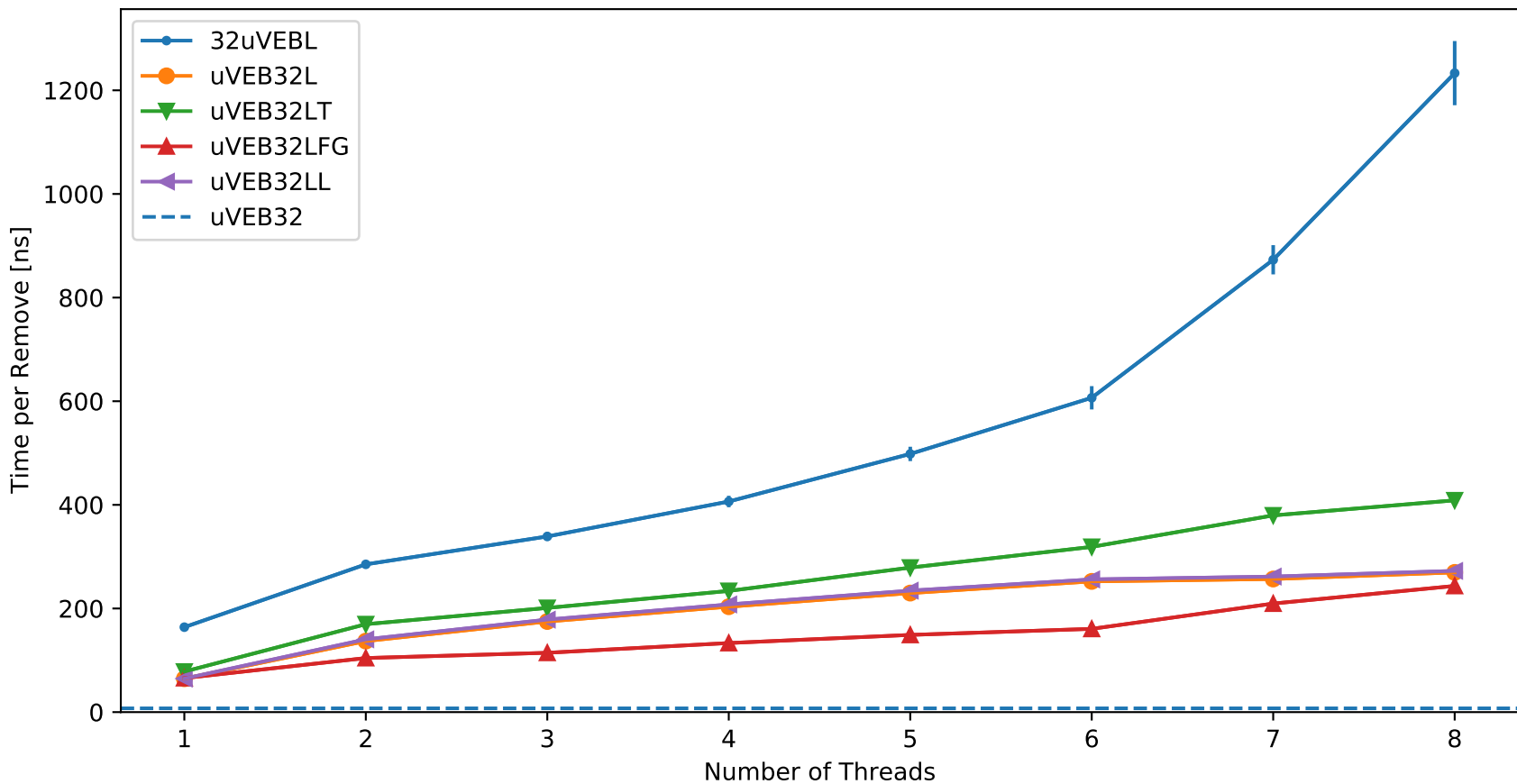


Time to Remove 'Size' Elements Parallel (Zoomed in; cluster distribution; 8 Threads)

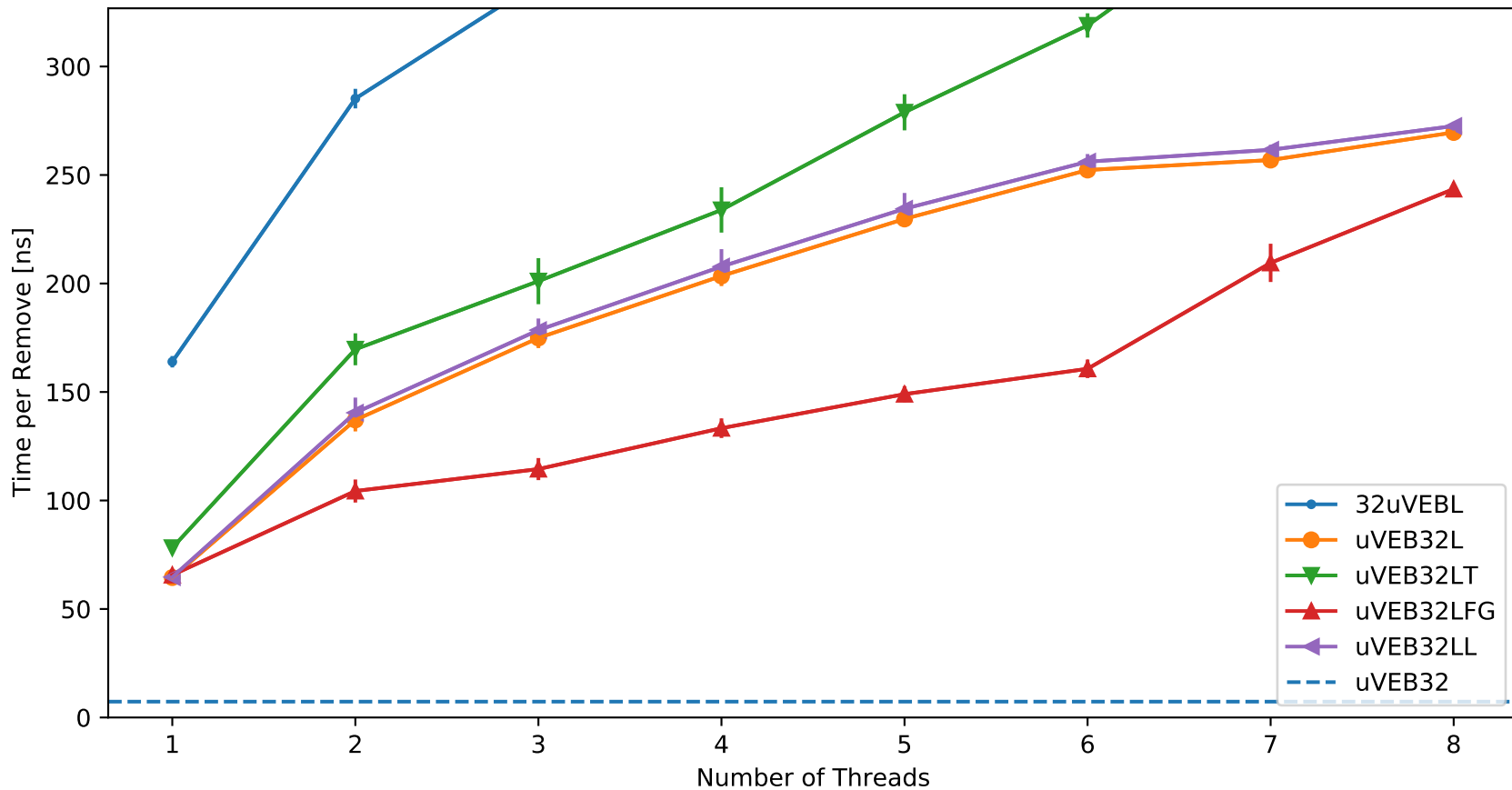




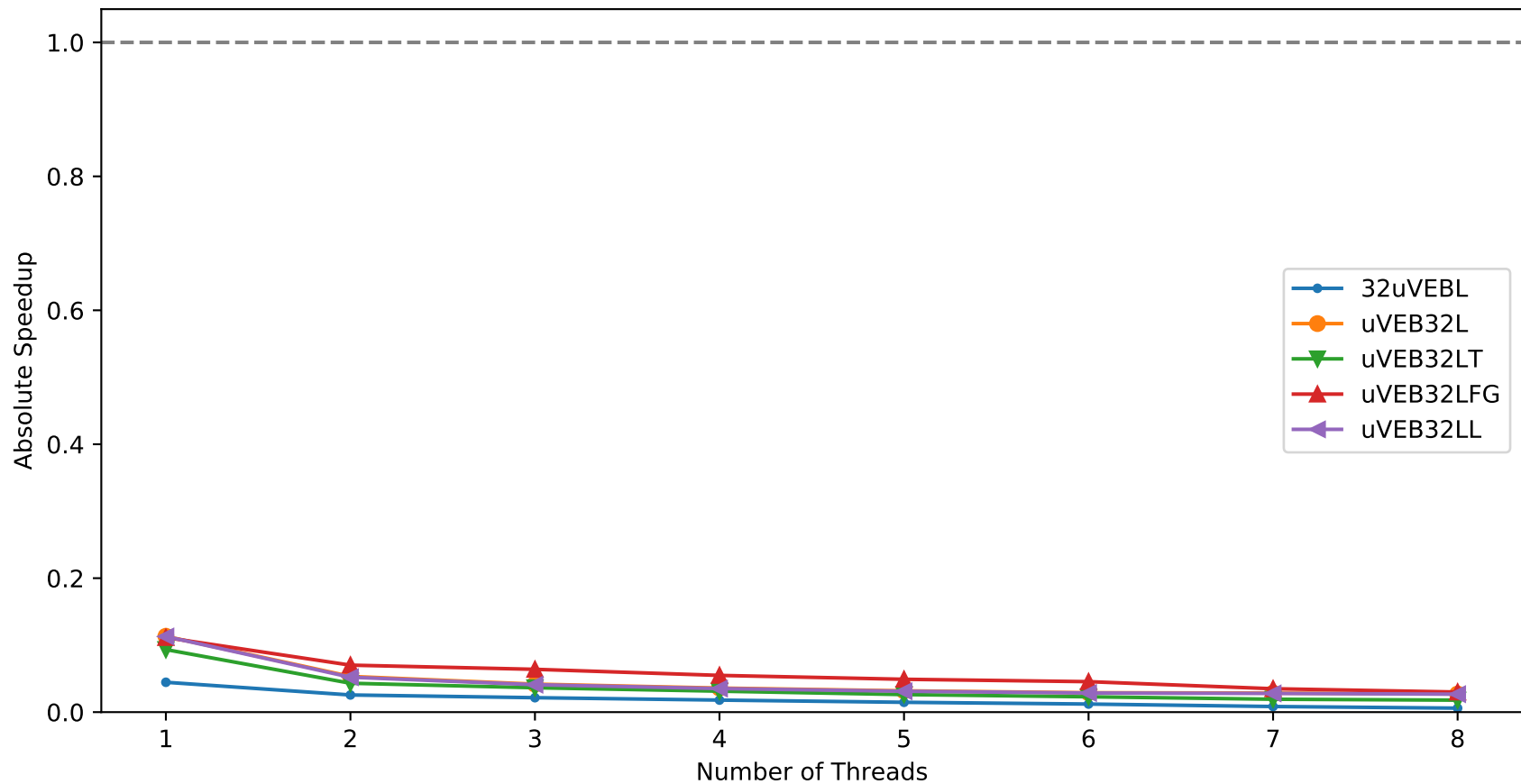
Time to Remove 'Size' Elements Parallel (cluster distribution; 2097152 Elements)



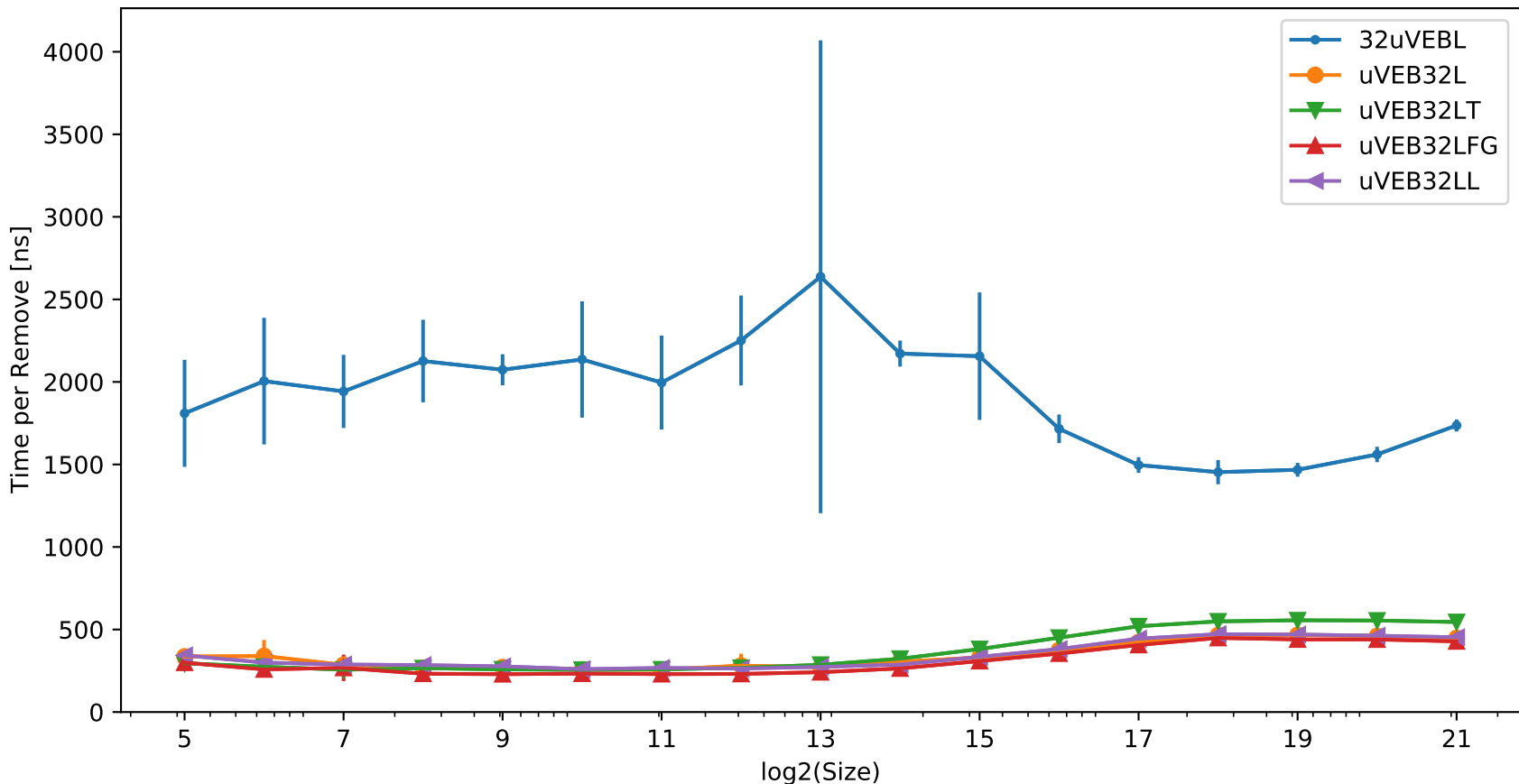
Time to Remove 'Size' Elements Parallel (Zoomed in; cluster distribution; 2097152 Elements)



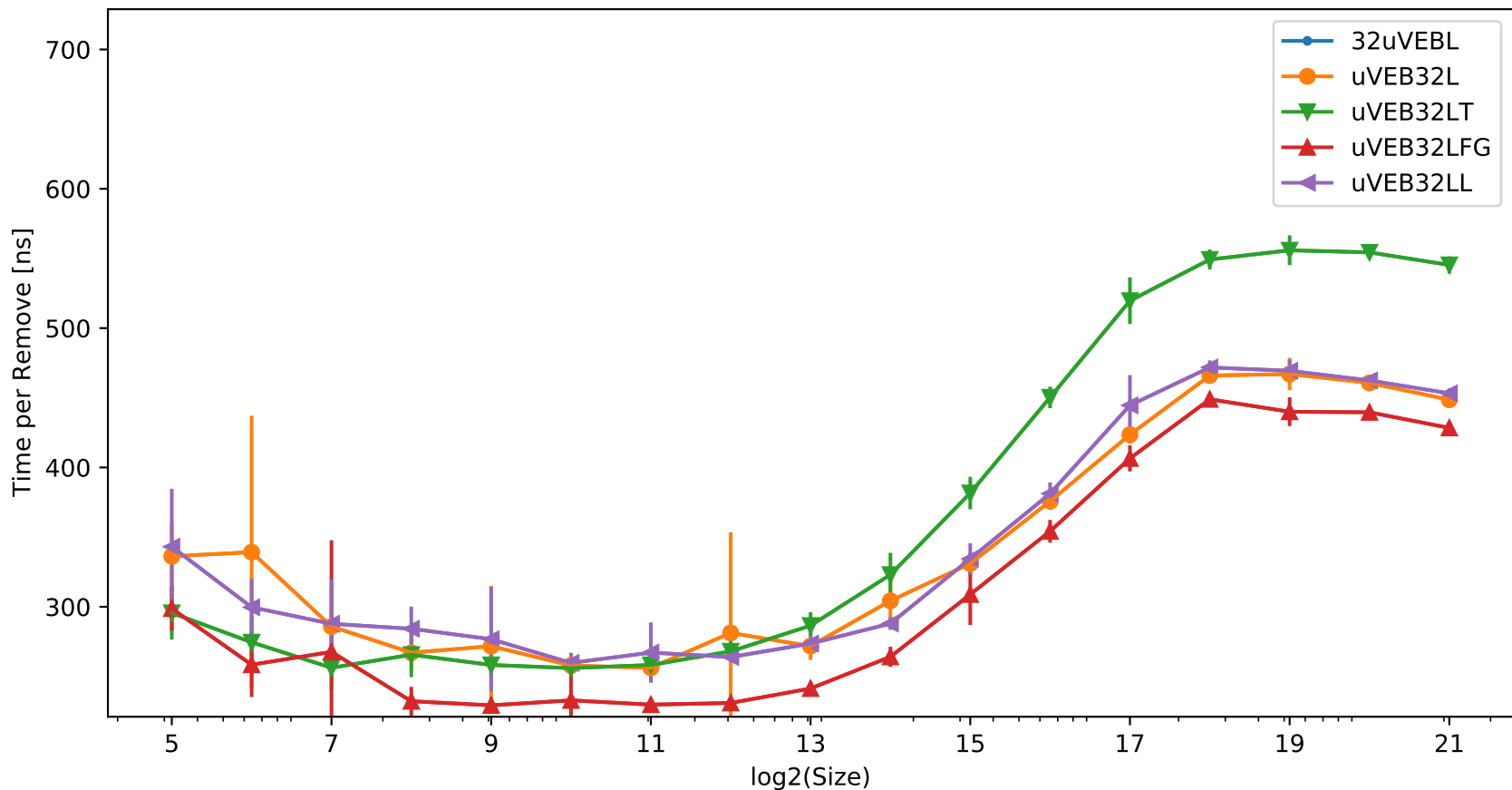
Speedup over uVEB32 to Remove 'Size' Elements Parallel (cluster distribution; 2097152 Elements)



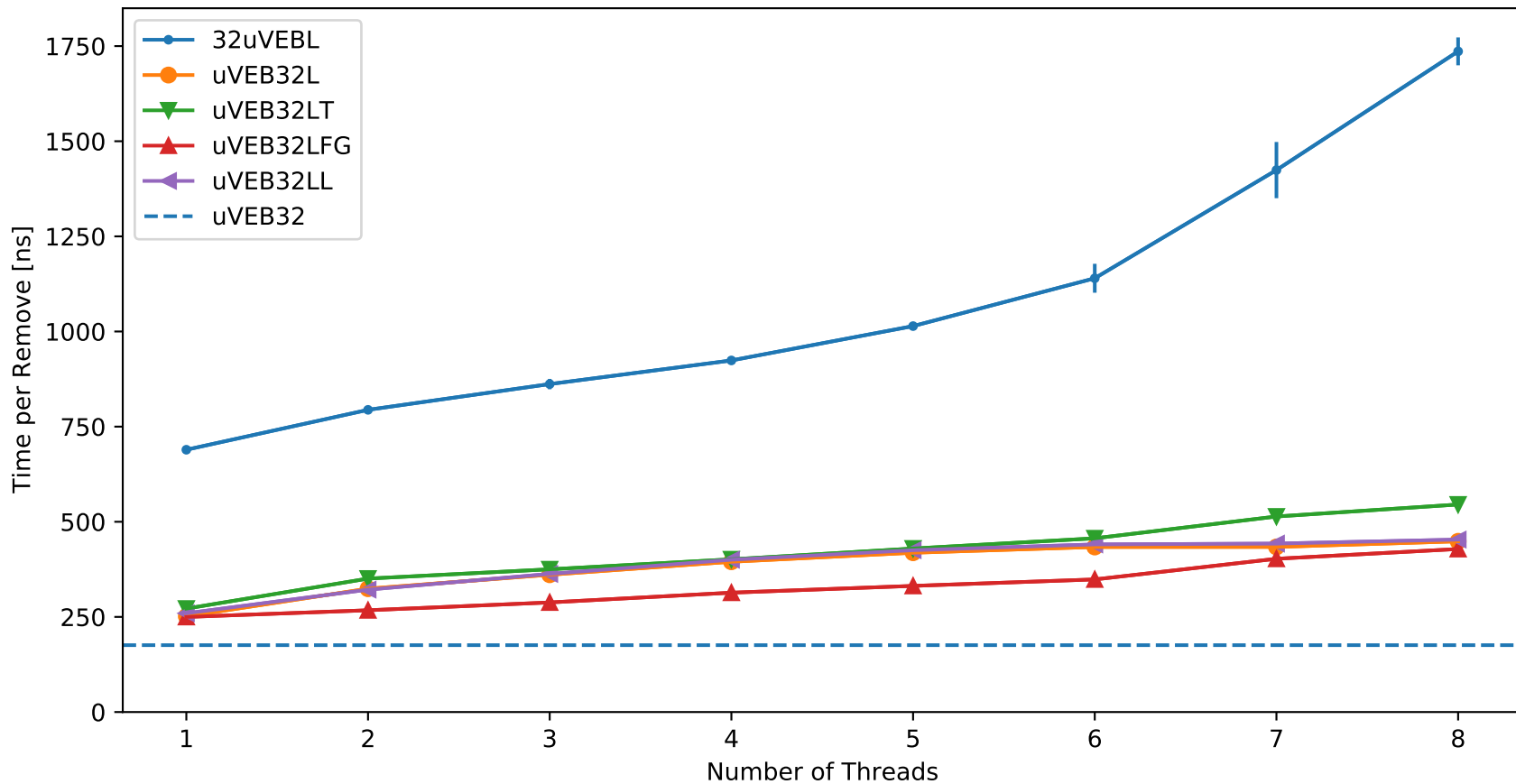
Time to Remove 'Size' Elements Parallel (normal distribution; 8 Threads)



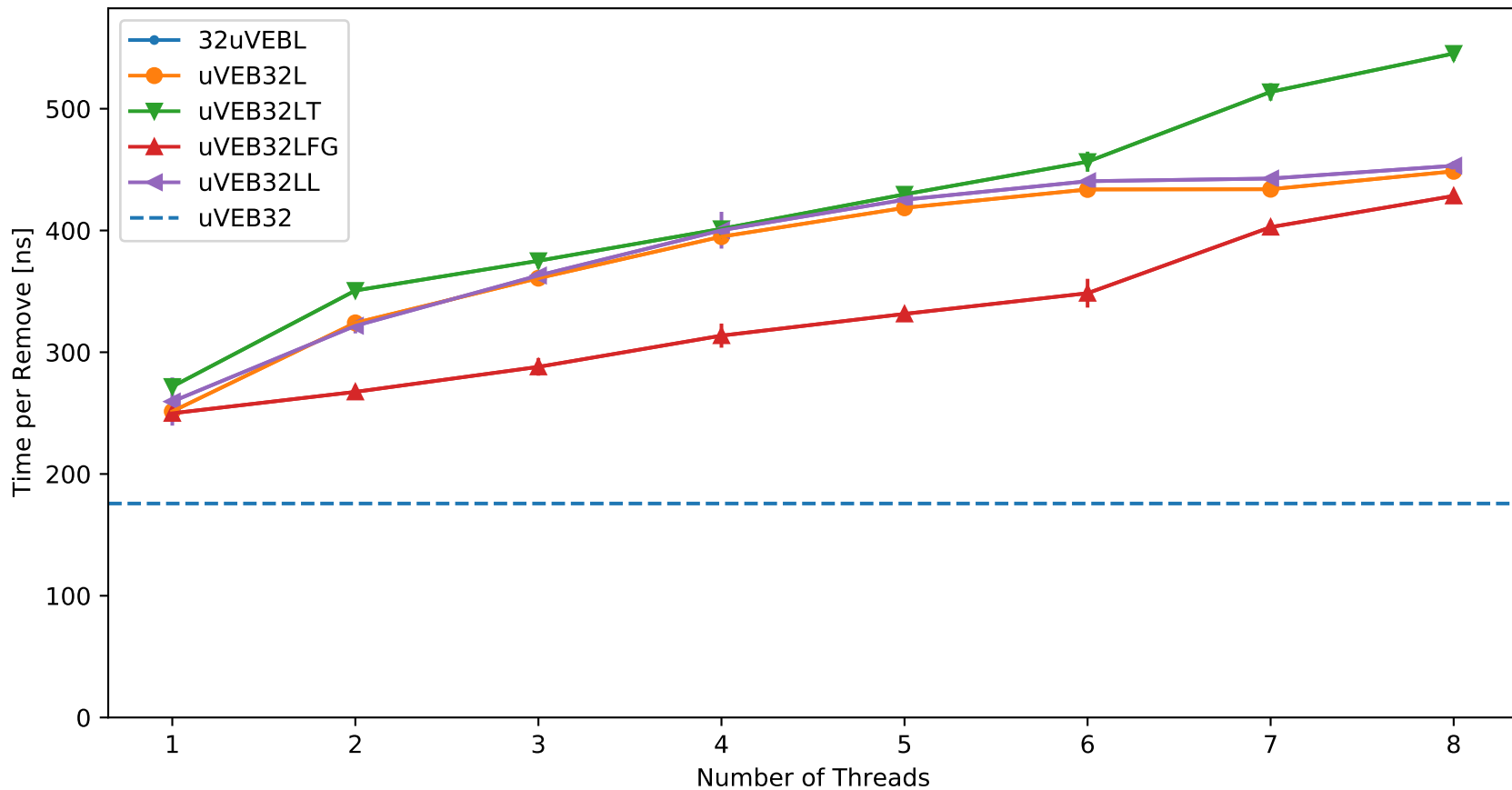
Time to Remove 'Size' Elements Parallel (Zoomed in; normal distribution; 8 Threads)



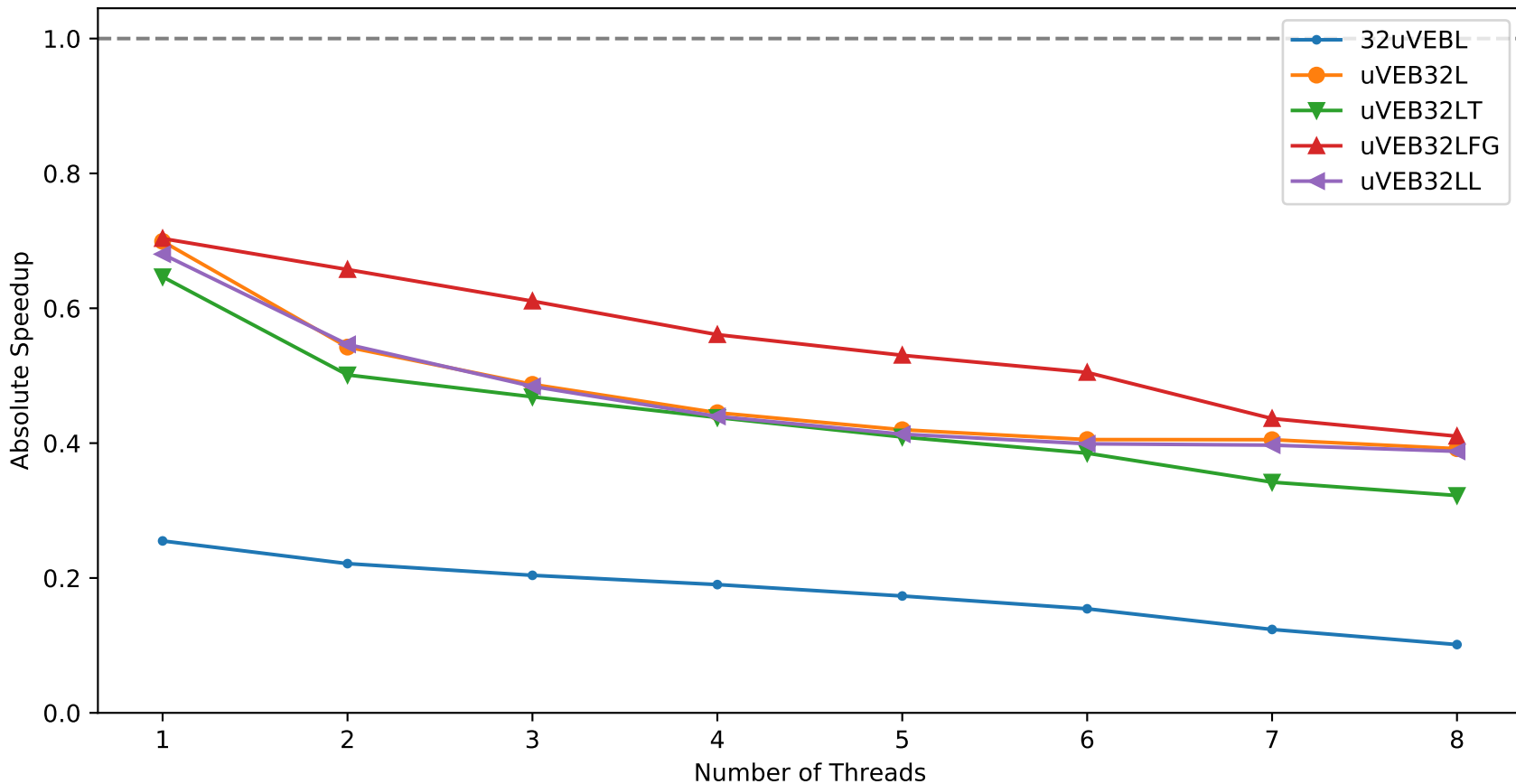
Time to Remove 'Size' Elements Parallel (normal distribution; 2097152 Elements)



Time to Remove 'Size' Elements Parallel (Zoomed in; normal distribution; 2097152 Elements)

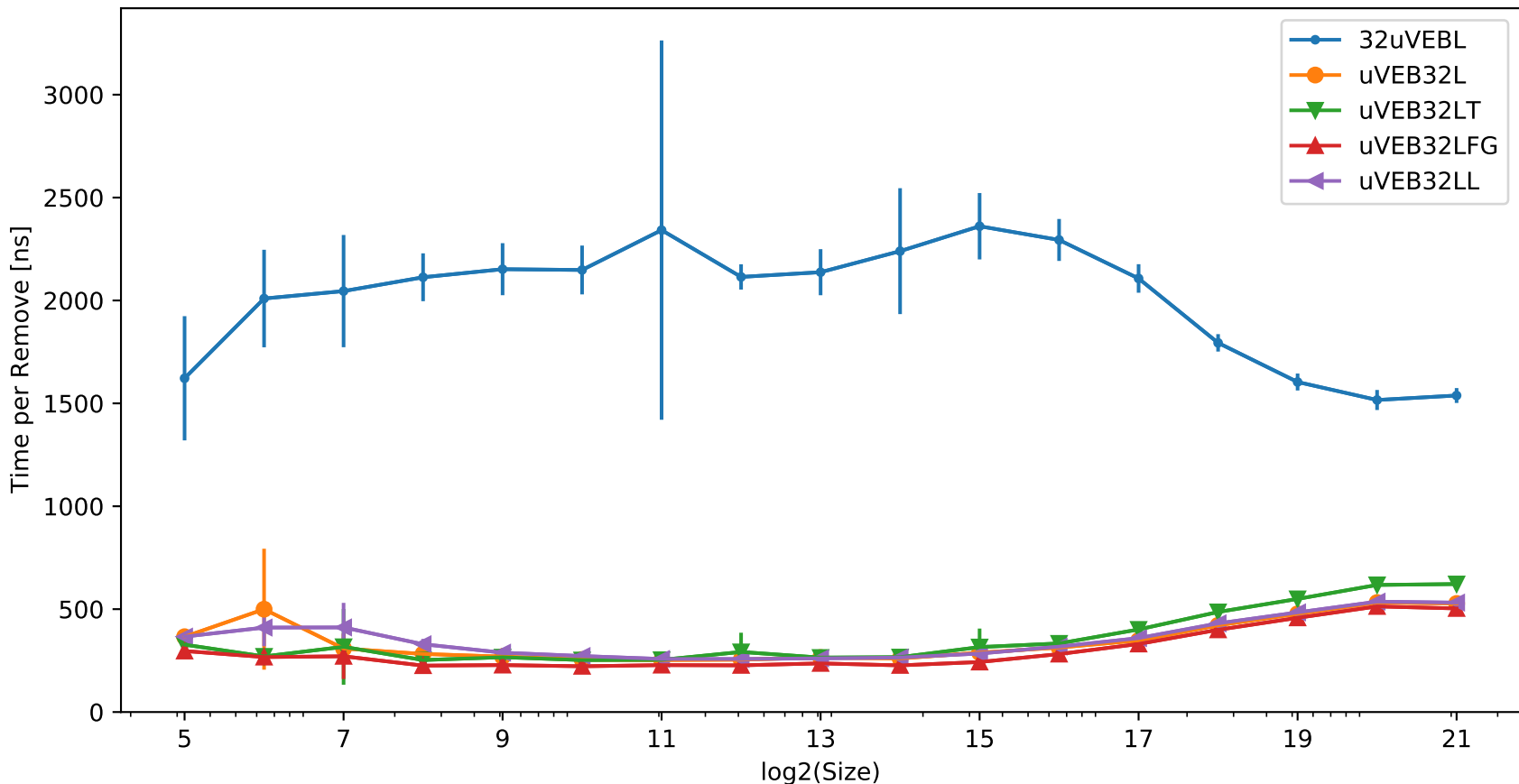


Speedup over uVEB32 to Remove 'Size' Elements Parallel (normal distribution; 2097152 Elements)

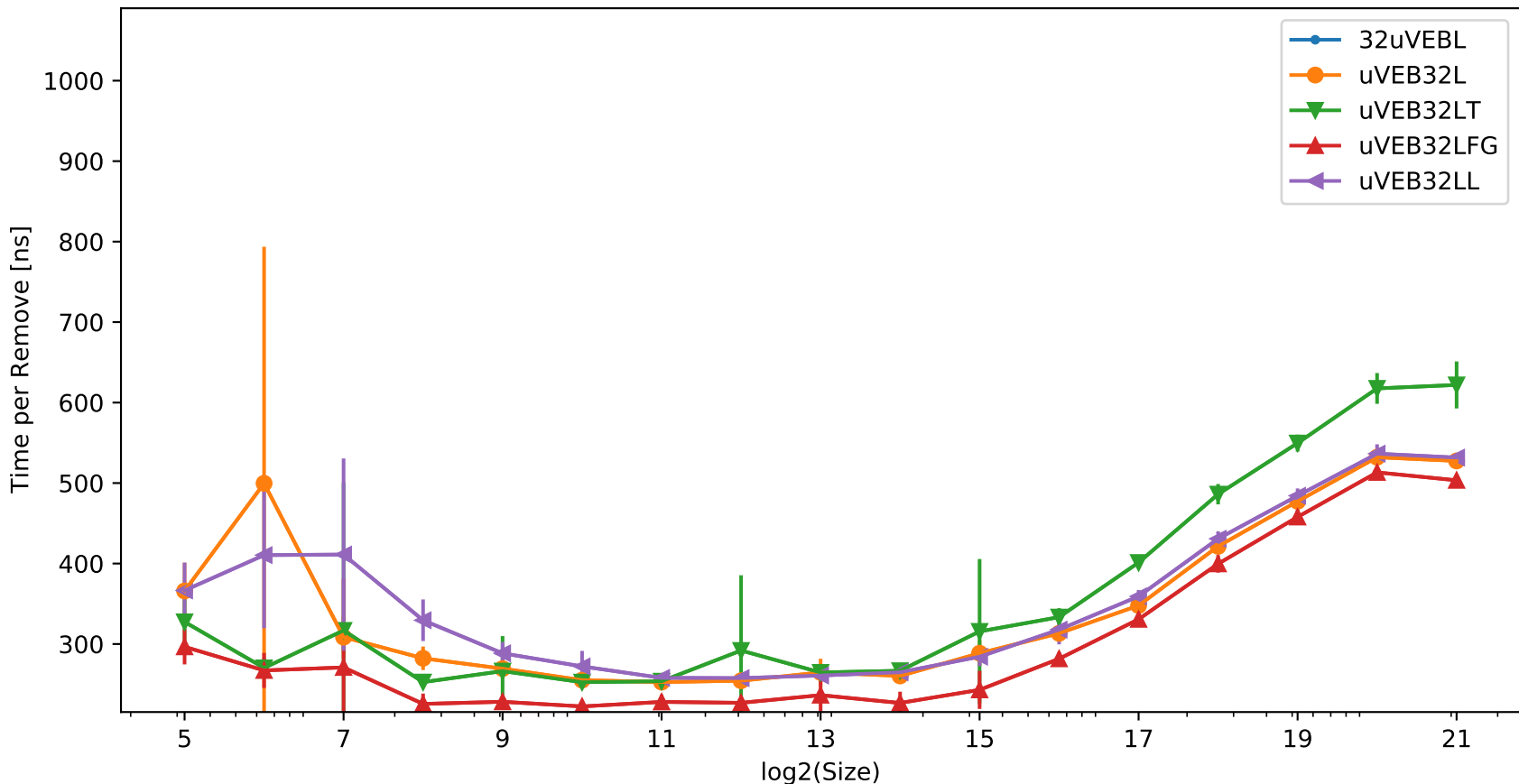




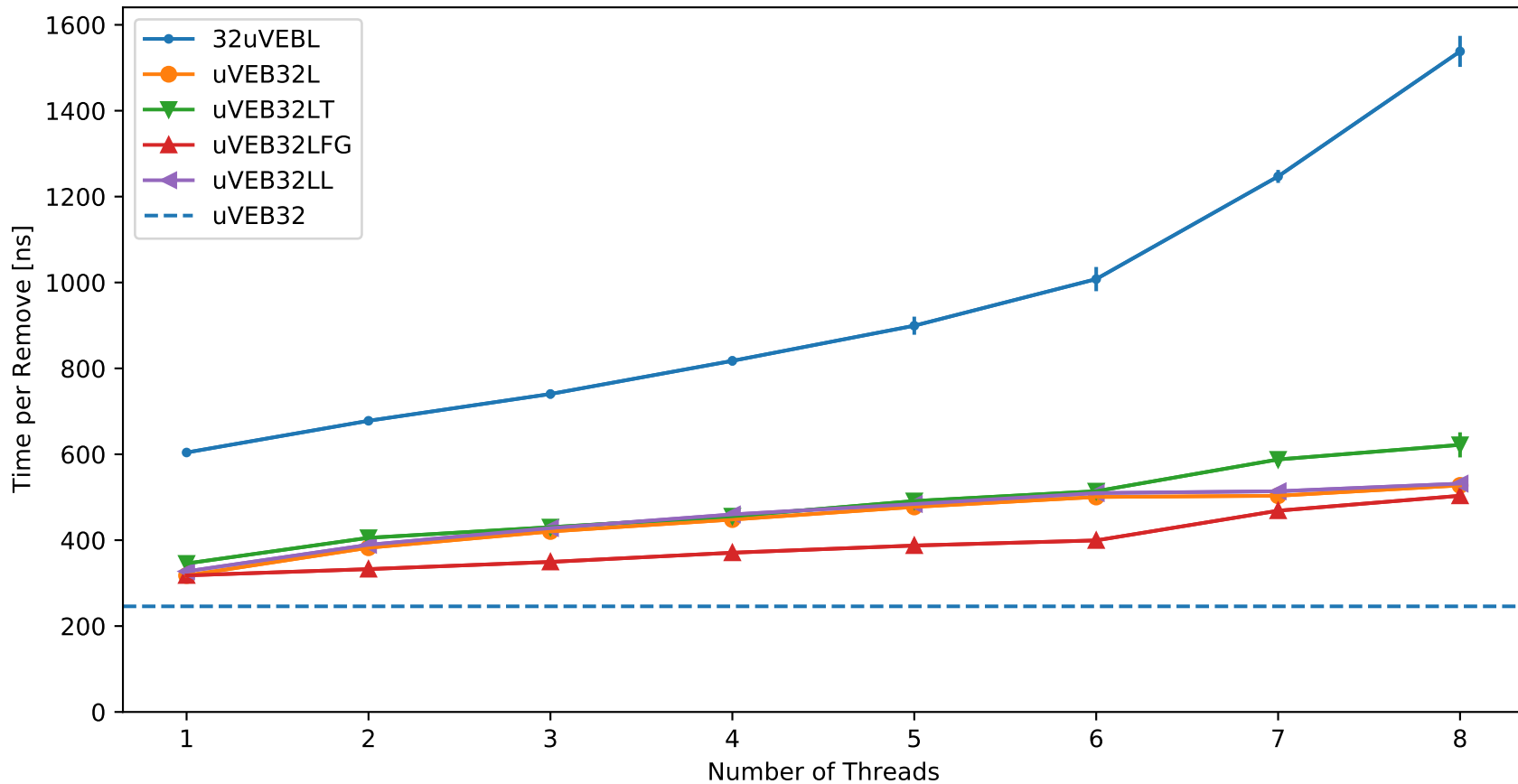
Time to Remove 'Size' Elements Parallel (incProb distribution; 8 Threads)



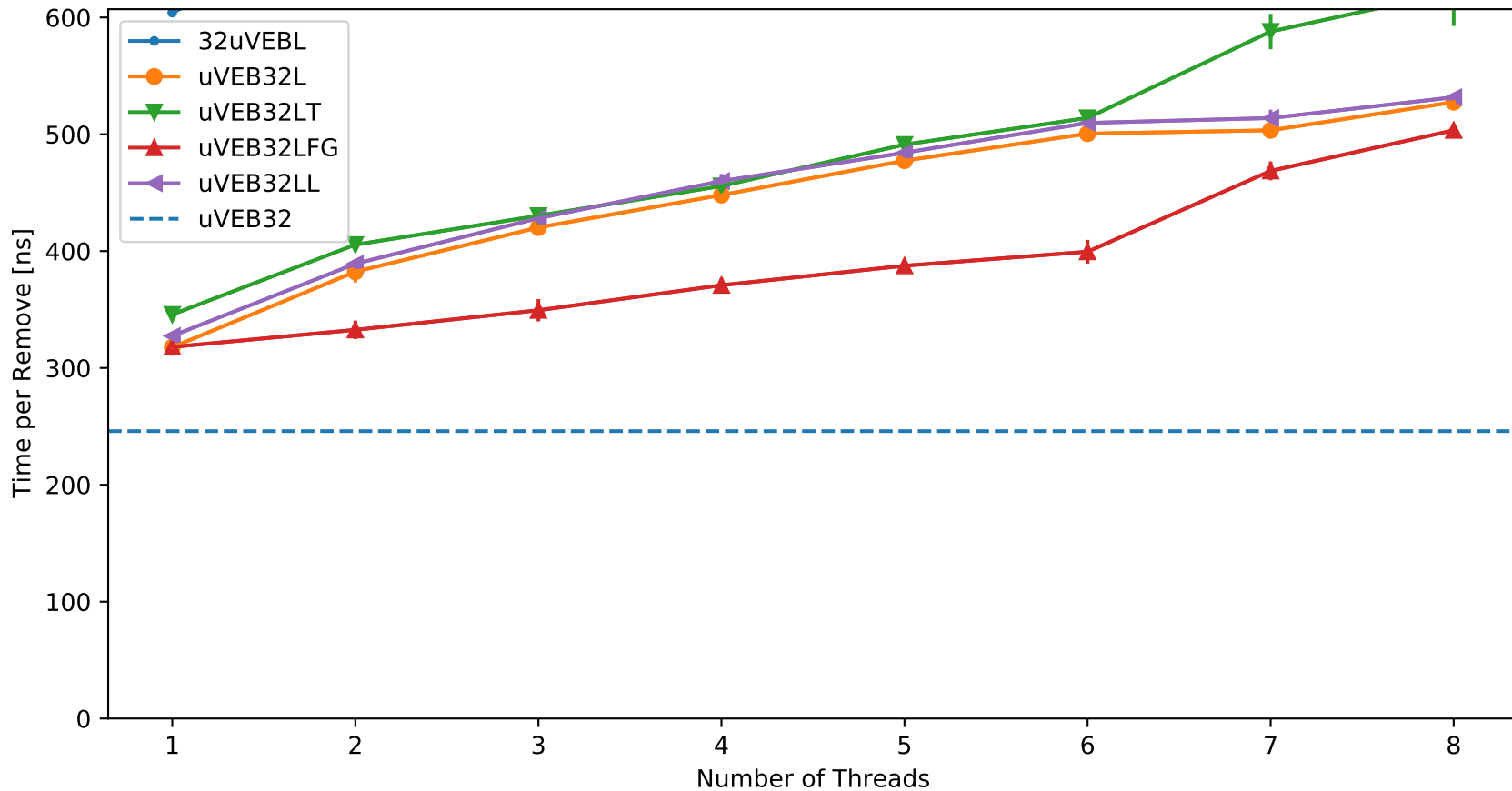
Time to Remove 'Size' Elements Parallel (Zoomed in; incProb distribution; 8 Threads)



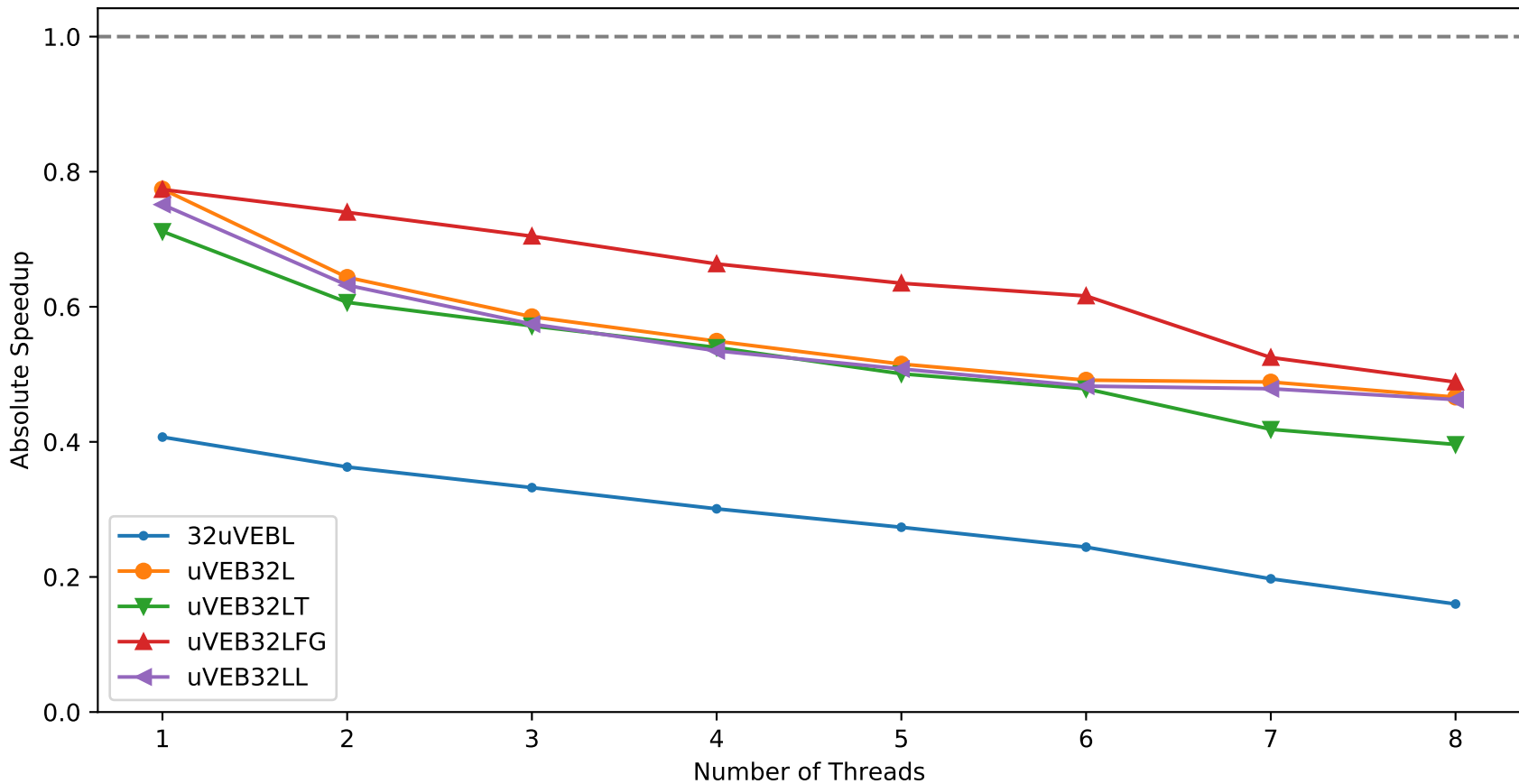
Time to Remove 'Size' Elements Parallel (incProb distribution; 2097152 Elements)



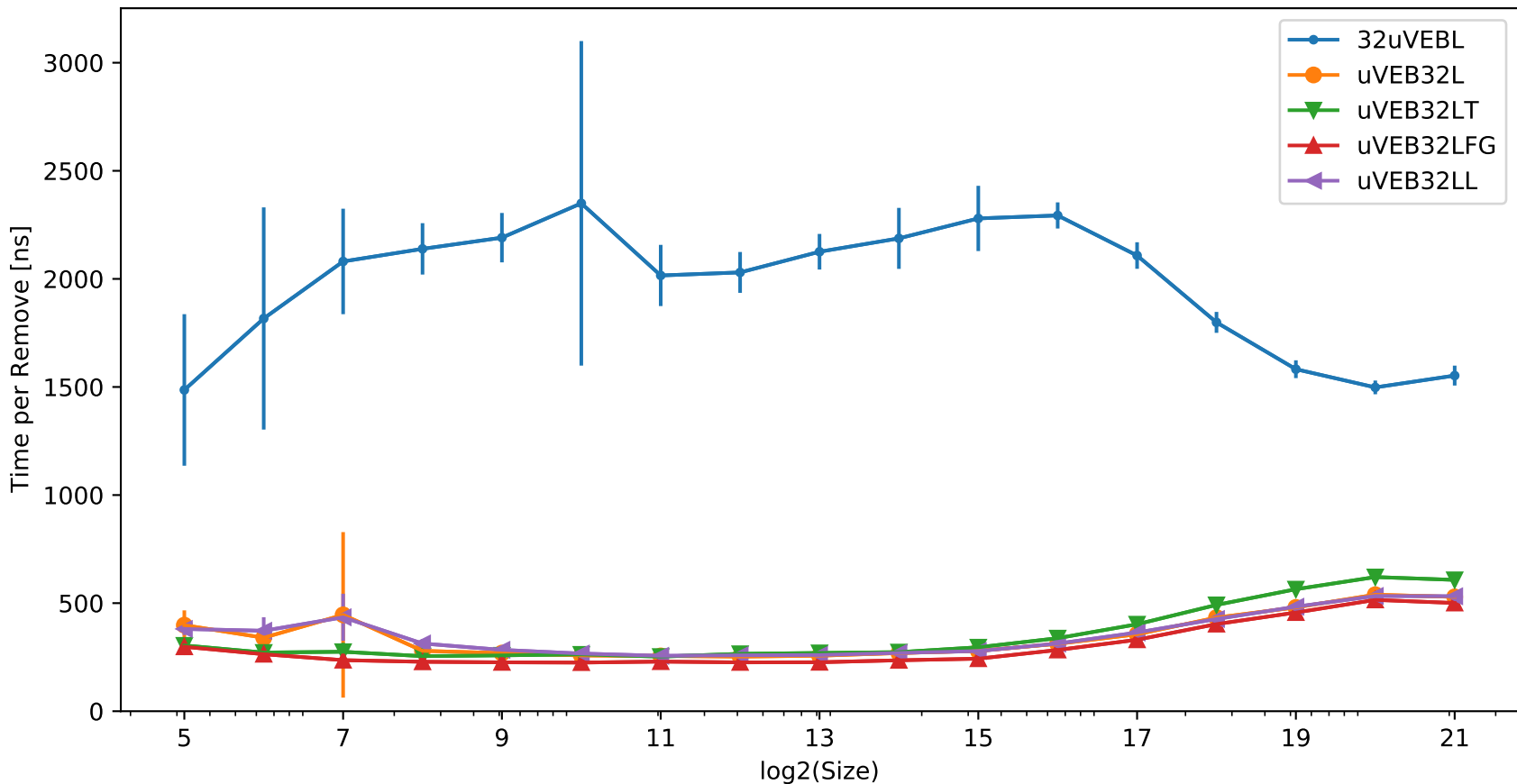
Time to Remove 'Size' Elements Parallel (Zoomed in; incProb distribution; 2097152 Elements)



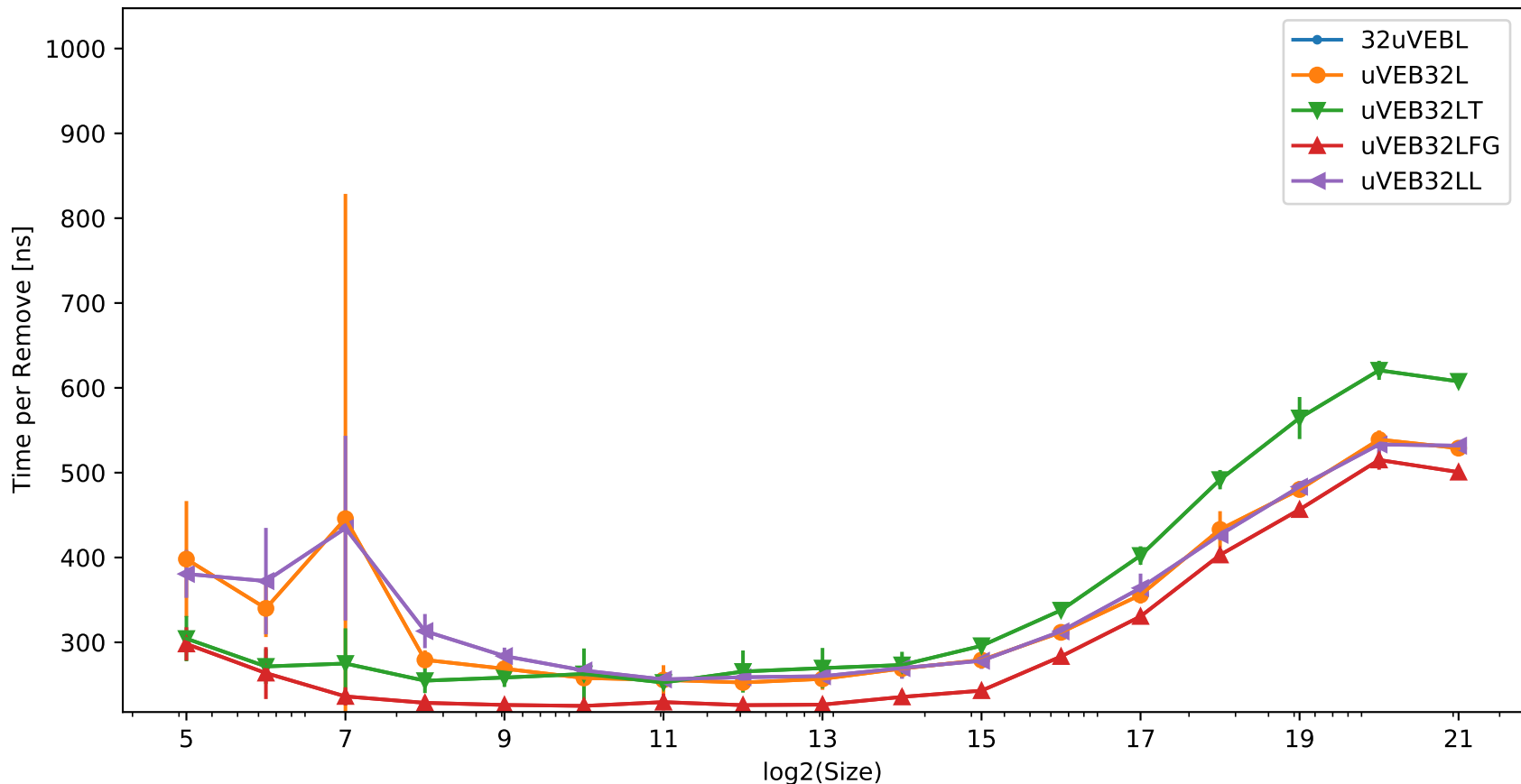
Speedup over uVEB32 to Remove 'Size' Elements Parallel (incProb distribution; 2097152 Elements)



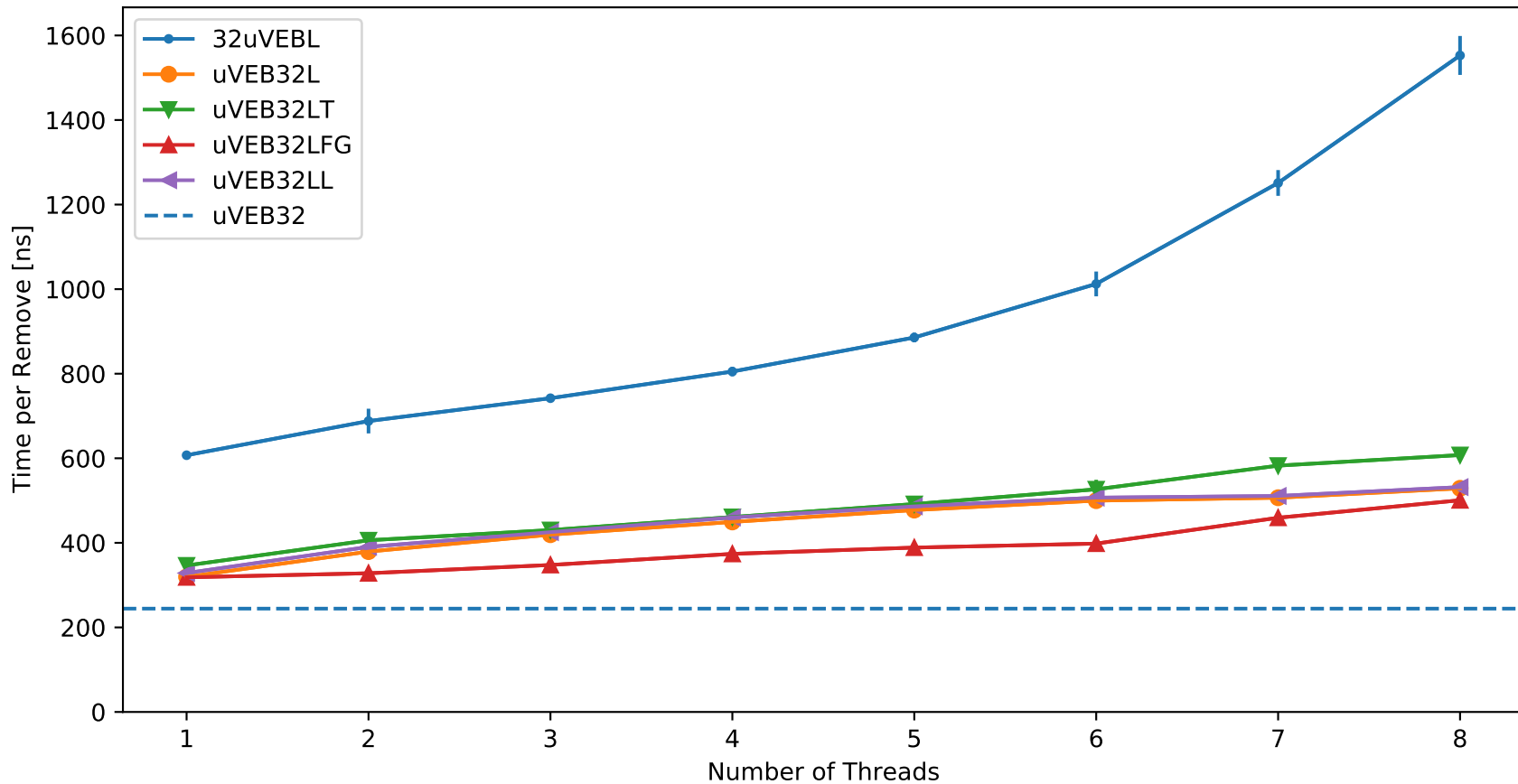
Time to Remove 'Size' Elements Parallel (decProb distribution; 8 Threads)



Time to Remove 'Size' Elements Parallel (Zoomed in; decProb distribution; 8 Threads)

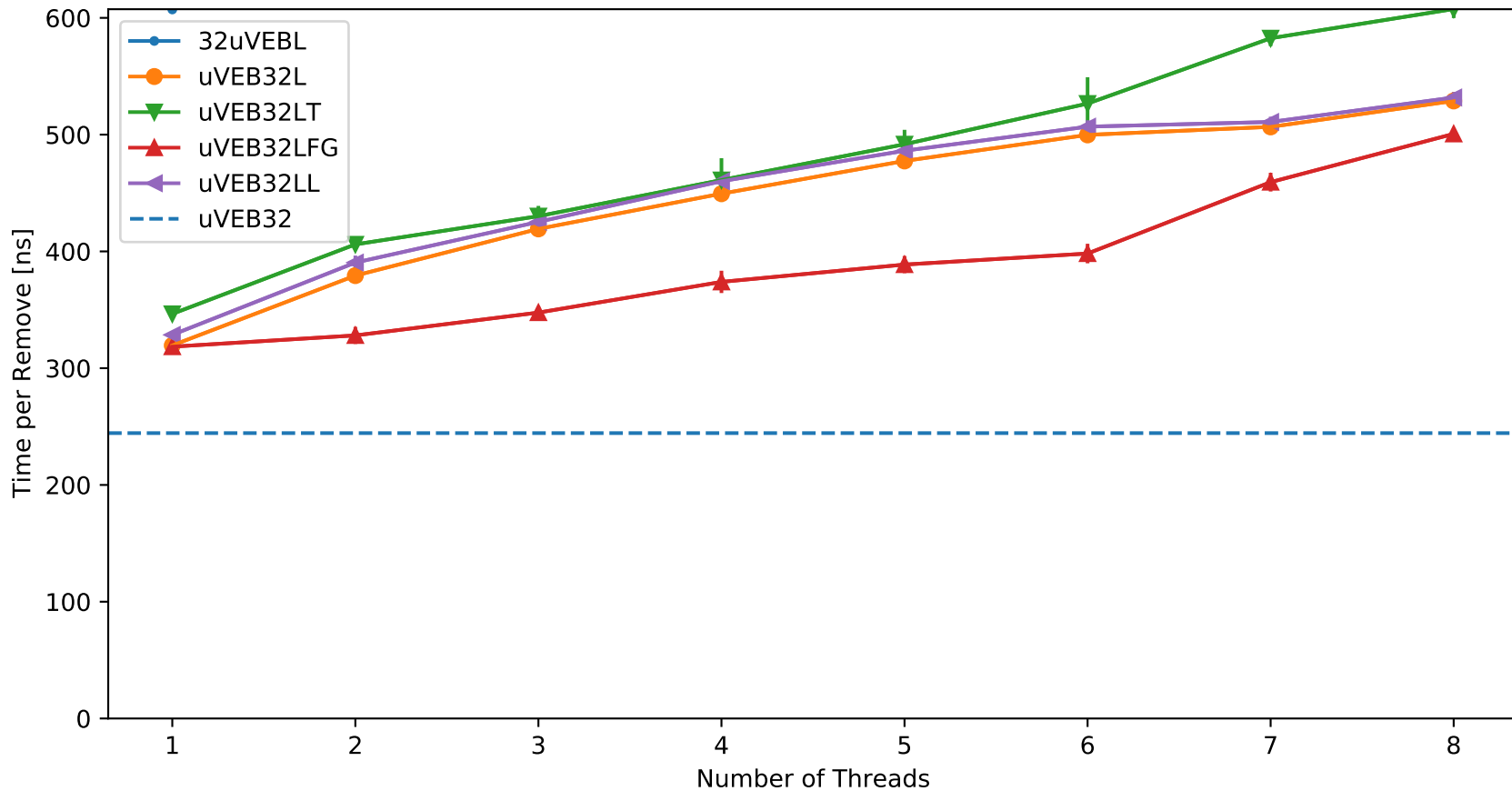


Time to Remove 'Size' Elements Parallel (decProb distribution; 2097152 Elements)





Time to Remove 'Size' Elements Parallel (Zoomed in; decProb distribution; 2097152 Elements)



Speedup over uVEB32 to Remove 'Size' Elements Parallel (decProb distribution; 2097152 Elements)

